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ABSTRACT

This engine performance (emission control systems) module is one of a series of competency-based modules in the Missouri Auto Mechanics Curriculum Guide. Topics of this module's five units are: positive crankcase ventilation (PCV) and evaporative emission control systems; exhaust gas recirculation (EGR); air injection and catalytic converters; inlet air temperature and intake manifold heat controls; and spark timing and idle speed controls. Unit 1 includes three lessons: PCV system fundamentals and service; construction and operation of evaporative emission control systems; and servicing evaporative emission control systems. The two lessons in unit 2 cover EGR operation and EGR service. Lessons in unit 3 cover construction/operation of air injection systems and catalytic converters and air injection and catalytic converter diagnosis and repair. Unit 4 contains two lessons, one on heated air inlet systems and the other on intake manifold heat controls. Lessons in unit 5 are on spark timing controls and idle speed controls. Each module of the Auto Mechanic's Curriculum Guide contains seven major components: competency profile; unit and specific objective sheets; information sheets; assignment sheets; job sheets; tests and answers; and a cross-reference table. Each module is packaged in three parts: an instructor's guide, a student reference, and student work sheets. The color-coded instructor's guide contains the lesson materials plus references and notes to the instructor. (NLA)

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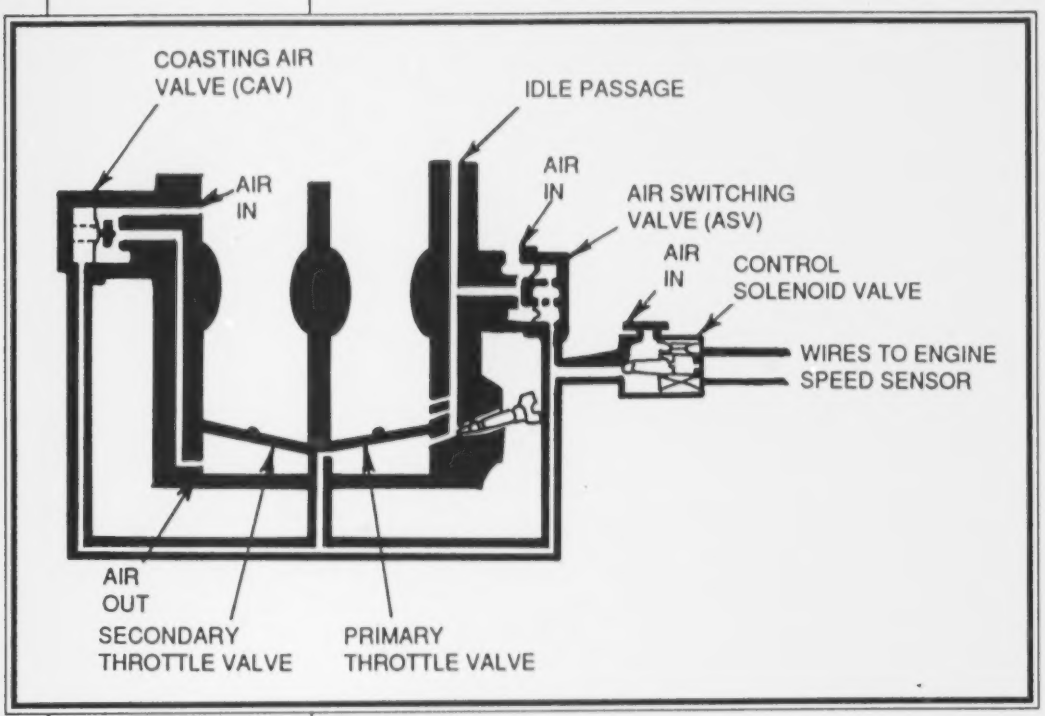
Instructor's Guide

Auto Mechanics
Curriculum Guide



Module 3

Engine Performance (Section C: Emission Control Systems)

Produced by
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INTRODUCTION TO AUTO MECHANICS
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ENGINE PERFORMANCE
ENGINE REPAIR
SUSPENSION AND STEERING
BRAKES
MANUAL DRIVE TRAIN AND AXLES
AUTOMATIC TRANSMISSION AND TRANSAXLES
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AUTO MECHANICS CURRICULUM

MODULE 3: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

INSTRUCTOR'S GUIDE

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FOREWORD

Once again, we are indebted to the teachers and administrators who provide their time, efforts, and professionalism to develop curriculum for trade, technical, and industrial education programs. The Engine Performance: Section C: Emission Control Systems module (the third of nine modules to make up the Missouri Auto Mechanics Curriculum Guide) is an outstanding example of what can be accomplished when the right people with the right attitude work together. The curriculum writers and subject matter experts who worked on this guide are to be commended for a job well done.

The module's format has been developed for competency-based teaching and testing. Job sheets within the guide evaluate specific competencies and can be managed with the Vocational Administrative Management System (VAMS). All major components of the module have been keyed to the Missouri Auto Mechanics Competency Profile, which was developed by industry and education professionals within Missouri.

Special appreciation is given to Larry Rains, the module's writer. Special appreciation is also given to Fred Smith, who served as a technical adviser during production of the module.

The format and curriculum management system found in this module may be new to many vocational educators. However, we are confident that, when used as designed, this module will allow for a more productive and rewarding educational experience for both teacher and student. Any future auto mechanics curriculum modifications will begin with the Missouri Auto Mechanics Curriculum Guide. Auto mechanics, like many technical fields, is undergoing constant and considerable change. We will annually evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

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ACKNOWLEDGEMENTS

Engine Performance: Section C: Emission Control Systems is the third of nine modules that make up the Missouri Auto Mechanics Curriculum Guide. Produced by the Instructional Materials Laboratory (IML), the guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). All modules in the guide are based on the Missouri Auto Mechanics Competency Profile, which in turn is based on and cross-referenced to the ASE task list. For years ASE has set the professional standards for automotive technicians. Therefore, a strong ASE orientation makes the guide an effective tool for preparing students to enter the technologically advanced field of auto mechanics.

IML extends special recognition to Larry Rains, the writer of Engine Performance: Section C: Emission Control Systems. Mr. Rains' thorough knowledge of automotive technology and years of teaching experience are evident throughout his work. Special recognition also goes to Fred Smith, who contributed heavily to the module as a technical adviser. Mr. Smith's attention to technical detail proved invaluable throughout the module's development.

IML gratefully acknowledges the important contribution of the advisory committee, which, among other tasks, developed the competency profile for the guide. The advisory committee members are listed below:

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Charles Waibel and Judith Moore, Division of Vocational and Adult Education, Department of Elementary and Secondary Education, Jefferson City, Mo.
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IML also acknowledges the field testers, who worked to ensure that the Engine Performance: Section C: Emission Control Systems module was developed into an effective and practical teaching tool. The field testers are listed below:

Field testers

Robert Barbarick, Four Rivers AVTS, Washington, Mo.
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Wayne Sweatt, Lake AVTS, Camdenton, Mo.

The support and contributions of the following IML staff members were instrumental to the development of this module:

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(SECTION C: EMISSION CONTROL SYSTEMS)

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UNIT V:	SPARK TIMING AND IDLE SPEED CONTROLS	EP/ECS 137

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HOW TO USE THE MISSOURI AUTO MECHANICS CURRICULUM GUIDE

Every module of the Missouri Auto Mechanics Curriculum Guide contains the following seven major components: (1) a competency profile, (2) objective sheets, (3) information sheets, (4) assignment sheets, (5) job sheets, (6) tests, and (7) a cross-reference table. Below is a discussion of the design of these components.

MISSOURI COMPETENCY PROFILE

The competency profile identifies 144 basic auto mechanics competencies. The profile divides the competencies into nine general areas, each of which serves as the basis for individual modules of instruction (such as the Engine Performance: Section C: Emission Control Systems module). The competency profile further divides these general areas into duty bands, each of which is identified by a capital letter. The Engine Performance: Section C: Emission Control Systems module covers Duty Band L, "Emission Control Systems." Under each duty band are listed several competencies, each of which is identified by an Arabic numeral. Note the below excerpt from the competency profile:

3	2	1	N	L. Emission Control Systems	ASE Task(s)
				1. Diagnose emission control systems and determine needed repairs	NONE
				2. Clean, inspect/replace PCV system components	H061 H063
				3. Clean, inspect/replace spark timing controllers	H064 H066
				4. Clean, inspect/replace idle speed controllers	H067 H070
				5. Clean, inspect/replace exhaust gas recirculation	H071 H074
				6. Clean, inspect/replace air management system	H075 H080
				7. Clean, inspect/replace inlet air temperature control	H083 H085
				8. Clean, inspect/replace intake manifold heat controls	H086 H088
				9. Clean, inspect/replace fuel vapor controls	H089 H092

As was noted above, the duty band "Emission Control Systems" is identified by the letter "L." The competency "Diagnose emission control systems and determine needed repairs" falls under Duty Band L and is identified by the Arabic numeral "1." Throughout the Engine Performance: Section C: Emission Control Systems module, therefore, the competency "Diagnose emission control systems and determine needed repairs" will be referred to as Competency L1. Some other competencies under Duty Band L include L2, "Clean, inspect/replace PCV system components," and L3, "Clean, inspect/replace intake spark timing controllers."

Also note that one or more ASE tasks are listed to the right side of most competencies on the profile. These ASE tasks are directly related to those competencies by which the tasks appear. However, a very small number of competencies, such as L1, cover no ASE tasks directly; therefore, the word "NONE" appears by these competencies.

(**NOTE:** The term "cross-reference table" will appear throughout the rest of this discussion. A cross-reference table is a chart that shows precisely how objectives, assignment sheets, test questions, and job sheets are related to individual competencies. The cross-reference table will be discussed later in more detail.)

INFORMATION SHEETS

The information sheets (or information outline) present the student with important facts and concepts relating to basic automotive technology and service procedures. The information sheets also explain why a procedure is necessary and why it must be performed in a certain manner. Though not intended to be as comprehensive as a textbook, the information sheets provide a good source of information to which the student can refer outside of class. Perhaps the information sheets can best be thought of as a thorough set of notes accompanying the instructor's classroom lecture.

ASSIGNMENT SHEETS

The assignment sheets serve one of two functions: they can either emphasize important cognitive information or instruct students in developing procedures specific to a particular vehicle. The "Notes to the Instructor," found on the table of contents section of each module, indicates how each assignment sheet is used.

(**NOTE:** Assignment sheets are not used to evaluate competencies directly. Only job sheets directly evaluate competencies.)

UNIT TESTS

Unit tests cover information relating to specific competencies. The student must obtain acceptable test scores (decided upon by the instructor) before receiving an evaluation for these competencies. (Since job sheets are used to evaluate competencies, the student, therefore, must receive an acceptable test score before doing certain job sheets.) The test ensures that the student has the minimum knowledge required to perform the competencies covered on the job sheets. On most tests, one group of questions covers information related exclusively to two or three competencies while another group of questions relates exclusively to several other competencies. Questions relating to a specific group of competencies are divided into parts. At the end of each part, a note like the following appears:

> (NOTE: The student must obtain a minimum score of ____ on Part I of the Unit I Test in order to receive an evaluation for Competencies L1 and L2.)

All the test questions and job sheets related to each competency are listed on the module's cross-reference table. The cross-reference table allows the instructor to determine what test questions a student must successfully complete before being eligible to perform the job sheets related to a particular competency. By observing the test notes and using the cross-reference table, the instructor can easily determine what job sheets a student is eligible to do as a result of his or her score on a particular part of a test.

OBJECTIVE SHEETS

The first page of each unit in the guide is an objective sheet, which states the unit's general and specific objectives. Below is the objective sheet for Unit II of the Engine Performance: Section C: Emission Control Systems module:

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT II: EXHAUST GAS RECIRCULATION

UNIT OBJECTIVE

After completing this unit, the student should be able to identify components of an exhaust gas recirculation system, explain the operation of the system, and diagnose and repair problems related to the system. The student will demonstrate mastery of the material by achieving a score of _____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1.

I. Identify the basic characteristics of an EGR system (Competencies L1 and L5, Unit II Test).

II. Identify the operation of a typical EGR system (Competencies L1 and L5, Unit II Test).

III. Identify the characteristics of an EGR valve (Competencies L1 and L5, Unit II Test).

IV. Identify the characteristics of an EGR shutoff solenoid and an EGR vacuum regulator solenoid (Competencies L1 and L5, Unit II Test).

Lesson 2.

I. Identify the procedure for testing an EGR system (Competency L5, Part II of the Unit II Test).

II. Identify the procedure for removing and installing an EGR valve (Competency L5, Part II of the Unit II Test).

III. Demonstrate the ability to:

a. Diagnose the EGR system (Competencies L1 and L5, JS1-L2-UII).

b. Remove and install an EGR valve (Competency L5, JS2-L2-UII).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks H071-H074.

Notice that the specific objectives are designated by Roman numerals. Also notice that the competency (or competencies) to which each objective relates is listed in parentheses behind each objective. Also listed in parentheses is the method by which the student's ability to perform the objective is evaluated.

A note identifying the ASE tasks that are covered by the unit's job sheets appears at the end of every objective sheet.

JOB SHEETS

Besides giving the student practical, hands-on experience in auto mechanics, job sheets provide a means of evaluating a student's ability to perform the competencies. The job sheets are, therefore, the key component of the Missouri Auto Mechanics Curriculum Guide. Below is an excerpt from the first page of a typical job sheet in the Engine Performance: Section C: Emission Control Systems module:

JS1-L1-UI

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

DIAGNOSING AND SERVICING THE PCV

Equipment:

Serviceable vehicle
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Visually inspect the PCV system and record results below. — — — —

   a. Hoses

      OK____ NOT OK____

   b. Crankcase filter

      OK____ NOT OK____

   c. PCV valve grommet

      OK____ NOT OK____

Notice that the job sheet is identified as JS1-L1-UI, which translates into Job Sheet 1, Lesson 1, Unit I. This shorthand system of job sheet identification is used throughout the curriculum guide.

(**NOTE:** Assignment sheets are identified with the same shorthand system. Assignment Sheet 1, Lesson 1, Unit I would be AS1-L1-UI.)

(**NOTE:** Both job sheets and assignment sheets are numbered consecutively within unit lessons.)

Also notice that, in the above job sheet excerpt, the spaces to the right of the page allow the instructor to evaluate the student on a particular job sheet activity. These spaces appear only by numbered items, which represent significant tasks; therefore, the instructor is freed from having to evaluate the minor steps of a procedure. At the beginning of each job sheet, the heading "3 2 1 N" indicates the four possible evaluations a student can receive. The meaning of the numbers and the letter N is as follows:

3 **Mastered** - can work independently with no supervision
2 **Requires Supervision** - can perform job completely with limited supervision
1 **Not Mastered** - requires instruction and close supervision
N **No Exposure** - no experience or knowledge in this area

The individual evaluations made throughout a job sheet are averaged together at the end of the job sheet. A note at the end of the job sheet explains how this average relates to the final evaluation for a particular competency. Shown below is a hypothetical example of note found at the end of a job sheet. The note explains that the average of the individual evaluations made throughout the job sheet is a partial evaluation for Competency A1. (Please note that the below example is hypothetical; the Engine Performance: Section C: Emission Control Systems Module contains no Competency A1.)

*Average of above evaluations — — — —

(*This average is the final evaluation for Competency A1.)

As automotive instructors know, an automobile contains many complex and interrelated components. A single general service task may involve several different procedures. In the Missouri Auto Mechanics Curriculum Guide, therefore, a competency may be evaluated over several job sheets; also one job sheet may evaluate several competencies. Though other modules in the Missouri Auto Mechanics Curriculum Guide do evaluate competencies with only one job sheet, all job sheets in the Engine Performance: Section C: Emission Control Systems module evaluate competencies over several job sheets. As will be demonstrated later, each job sheet is accompanied by a thorough set of instructions, explaining how each of the final job sheet averages is to be used. The cross-reference table is also quite helpful in showing which job sheets evaluate which competencies.

CROSS-REFERENCE TABLE

The cross-reference table can quickly reveal how competencies relate to instructional objectives, job sheets, assignment sheets, and test items. Note the following excerpt from the Engine Performance: Section C: Emission Control Systems module cross-reference table:

MODULE: ENGINE PERFORMANCE (SECTION C: EMISSION CONTROL SYSTEMS)
CROSS-REFERENCE TABLE OF INSTRUCTIONAL MATERIALS

Competency	Instructional Objective	Assignment Sheet	Job Sheet	Test Item	Notes
L1	UI-L1-I, UI-L1-II, UI-L1-III, UI-L1-IV, UI-L1-V; UII-L1-I, UII-L1-II, UII-L1-III, UII-L1-IV; UIII-L1-I, UIII-L1-II, UIII-L1-III, UIII-L1-IV; UIV-L1-I, UIV-L1-II, UIV-L1-III, UIV-L1-IV, UIV-L1-V, UIV-L2-I, UIV-L2-II, UIV-L2-III, UIV-L2-IV, UIV-L2-V; UV-L1-I, UV-L1-II, UV-L1-III, UV-L1-IV, UV-L1-V, UV-L2-I, UV-L2-II	AS1-L3-UI AS1-L2-UII AS1-L2-UIII AS1-L2-UIV AS1-L1-UV AS2-L1-UV AS1-L2-UV AS2-L2-UV	JS1-L1-UI JS1-L3-UI JS1-L2-UII JS1-L2-UIII JS2-L2-UIII JS1-L1-UIV JS1-L2-UIV JS2-L2-UIV JS1-L1-UV JS2-L1-UV JS1-L2-UV JS2-L2-UV	UI 1-10 UII 1-10 UIII 1-14 UIV 1-16 UV 1-15	

The above excerpt lists all the instructional objectives in the module that cover Competency L1. The cross-reference table also indicates the test questions that cover Competency L1. Just as importantly, the table reveals at a glance all the job sheets that a student must perform before he or she can receive an evaluation for Competency L1. By looking at the cross-reference table, the instructor can, therefore, quickly determine what test questions a student needs to answer and what job sheets a student needs to perform before receiving a final evaluation for a particular competency.

HOW AND WHY COMPETENCIES ARE EVALUATED OVER SEVERAL JOB SHEETS

As noted above, Competency L1 ("Diagnose emission control systems and determine needed repairs") covers four ASE tasks. A job sheet covering all aspects of this complex task would be unreasonably long and overly complicated. As was indicated above, the Missouri Auto Mechanics Curriculum Guide allows the student to perform several job sheets in order to receive an evaluation for Competency L1. These job sheets are listed below:

JS1-L1-UI:	Diagnosing and Servicing the PCV
JS1-L3-UI:	Testing Evaporative Emission Control System Performance
JS1-L2-UII:	Diagnosing the EGR System
JS1-L2-UIII:	Testing the Performance of an Exhaust Pulse Type Air Injection System
JS2-L2-UIII:	Testing the Performance of an Air Pump Type Air Injection System
JS1-L1-UIV:	Testing the Operation of the Heated Air Inlet System
JS1-L2-UIV:	Testing the Operation of the Intake Manifold Heat Control
JS2-L2-UIV:	Testing the Performance of the Fuel Evaporation Heater
JS1-L1-UV:	Testing the Dual Diaphragm Distributor Advance/Retard
JS2-L1-UV:	Testing the Operation of the Transmission-Controlled Spark System
JS1-L2-UV:	Testing the Operation of the Deceleration Valve
JS2-L2-UV:	Testing and Adjusting the ISC Motor

The activities in the above job sheets satisfy Missouri Competency L1 and the ASE tasks that accompany L1. At the end of each job sheet relating to L1, a note explains that the individual evaluations made throughout the job sheet are averaged together to determine a partial evaluation for L1. The note also indicates on what job sheet the final evaluation for L1 will be determined. Below is an example of the note found at the end of JS1-L1-UI:

*Average of above evaluations — — — —

(*This average is a partial evaluation for Competency L1. This average is also the final evaluation for Competency L2. Final evaluation for L1 will be made at the end of JS2-L2-UV.)

(NOTE: The above note indicates that JS1-L1-UI also serves as a final evaluation for Competency L2. In the Missouri Auto Mechanics Curriculum Guide, job sheets often evaluate more than one competency. The job sheet notes clearly indicate which competency is being evaluated.)

At the end of JS2-L2-UV, the following instructions explain how the final evaluation for L1 is to be made:

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency L1 by averaging the evaluations of JS1-L1-UI, JS1-L3-UI, JS1-L2-UI, JS1-L2-UII, JS1-L2-UIII, JS2-L2-UIII, JS1-L1-UIV, JS1-L2-UIV, JS2-L2-UIV, JS1-L1-UV, JS2-L1-UV, JS1-L2-UV, and JS2-L2-UV. Determine the student's final evaluation for Competency L4 by averaging the evaluations of JS1-L2-UV and JS2-L2-UV. Use the spaces provided below.

A. Final evaluation for Competency L1	Evaluation 3	2	1	N
JS1-L1-UI	—	—	—	—
JS1-L3-UI	—	—	—	—
JS1-L2-UII	—	—	—	—
JS1-L2-UIII	—	—	—	—
JS2-L2-UIII	—	—	—	—
JS1-L1-UIV	—	—	—	—
JS1-L2-UIV	—	—	—	—
JS2-L2-UIV	—	—	—	—
JS1-L1-UV	—	—	—	—
JS2-L1-UV	—	—	—	—
JS1-L2-UV	—	—	—	—
JS2-L2-UV	—	—	—	—
Final evaluation for Competency L1	—	—	—	—

PACKAGING OF THE AUTO MECHANICS CURRICULUM GUIDE

Each module in the Auto Mechanics Curriculum Guide is packaged in three components: an instructor's guide, a student reference, and student work sheets. The instructor's guide includes the following items, all of which are color coded:

Cross-reference table (color-coded white)
Objective sheets (color-coded white)
Table of contents, references, notes to the instructor, answer sheets for assignment sheets and tests (color-coded pink)
Information sheets (color-coded green)
Assignment sheets (color-coded tan)
Job sheets (color-coded blue)
Unit tests (color-coded yellow)

The student reference contains copies of the objective sheets and information sheets from the instructor's guide. The student work sheets include consumable items from the instructor's guide, such as job sheets, assignment sheets, and unit tests. For convenience, the page numbers of the items in the student reference and in the work sheets are the same as those in the instructor's guide; therefore, page numbers in the student reference and work sheets are not consecutive. All student reference pages and work sheet pages are white.

Competency profiles for the guide are packaged in groups of ten along with a copy of the ASE task list.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT I: POSITIVE CRANKCASE VENTILATION AND EVAPORATIVE EMISSION CONTROL SYSTEMS

UNIT OBJECTIVE

After completing this unit, the student should be able to identify the components and operating principles of a PCV system and diagnose and repair problems relating to the system. The student will demonstrate mastery of the material by achieving a score of _____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1.

I. Identify the function and purpose of a positive crankcase ventilation system (Competencies L1 and L2, Parts I and II of the Unit I Test).

II. Identify the principles of operation of a typical PCV system (Competencies L1 and L2, Parts I and II of the Unit I Test).

III. Identify the construction of a PCV system (Competencies L1 and L2, Parts I and II of the Unit I Test).

IV. Identify the principles of operation of a PCV valve (Competencies L1 and L2, Parts I and II of the Unit I Test).

V. Identify the characteristics of PCV valve flow (Competencies L1 and L2, Parts I and II of the Unit I Test).

VI. Identify the procedure for inspecting the PCV system (Competency L2, Part II of the Unit I Test).

VII. Identify the procedure for servicing the PCV system (Competency L2, Part II of the Unit I Test).

VIII. Demonstrate the ability to:

a. Diagnose and service PCV systems (Competencies L1 and L2, JS1-L1-UI).

Lesson 2.

I. Identify the characteristics of evaporative emission control systems (Competency L9, Part III of the UI Test).

II. Identify fuel tank construction in relation to evaporative emission control systems (Competency L9, Part III of the UI Test).

III. Identify the characteristics of a charcoal canister (Competency L9, Part III of the UI Test).

IV. Identify the characteristics of the carburetor fuel bowl vent (Competency L9, Part III of the UI Test).

V. Identify the characteristics of charcoal canister purge control (Competency L9, Part III of the UI Test).

VI. Identify the characteristics of carbon element air cleaner (Competency L9, Part III of the UI Test).

Lesson 3. I. Identify the procedure for inspecting evaporative emission control systems (Competency L9, Part III of the UI Test).

II. Demonstrate the ability to:

a. Test the performance of the evaporative emission control system (Competencies L1 and L9, JS1-L3-UI).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks H061--H063 and H089-H092.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT I: POSITIVE CRANKCASE VENTILATION AND EVAPORATIVE EMISSION CONTROL SYSTEMS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: PCV SYSTEM FUNDAMENTALS AND SERVICE

   a. Information outline

   b. Assignment sheet

      AS1-L1-UI: PCV Systems

   c. Job sheet

      JS1-L1-UI: Diagnosing and Servicing the PCV

2. Lesson 2: CONSTRUCTION AND OPERATION OF EVAPORATIVE EMISSION CONTROL SYSTEMS

   a. Information outline

   b. Assignment sheet

      AS1-L2-UI: Construction and Operation of Evaporative Emission Control Systems

3. Lesson 3: SERVICING EVAPORATIVE EMISSION CONTROL SYSTEMS

   a. Information outline

   b. Assignment sheet

      AS1-L3-UI: Procedure for Testing Evaporative Emission Control System Performance

   c. Job sheet

      JS1-L3-UI: Testing Evaporative Emission Control System Performance

E. Unit test

F. Answers to unit test

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REFERENCES

Chrysler Corporation. Oxygen Feedback Systems. Chrysler Corporation, 1983.

Chrysler Corporation. Technical Guide, 1.4, 1.6, 2.0, and 2.6 Liter Engine Performance. Chrysler Corporation, 1982.

Chrysler Corporation. Technical Guide, 3.7/5.2 Liter Engine Performance. Chrysler Corporation, 1982.

Ford Parts and Service Division. EEC System Operation. Ford Parts and Service Division, 1986.

Ford Parts and Service Division. 1984 Car Shop Manual, Emission Diagnosis. Ford Parts and Service Division, 1983.

General Motors Corporation. C-4 Engine Performance. General Motors Corporation, 1980.

General Motors Corporation. 1982 Buick Skyhawk Chassis and Body Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1982 Chevrolet Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1989 R-V-G-P Light Duty Truck Service Manual, 10-30 Series. General Motors Corporation, 1988.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Students should do AS1-L1-UI and AS1-L2-UI before taking the Unit I Test. Students should do AS1-L3-UI in conjunction with JS1-L3-UI.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT I: POSITIVE CRANKCASE VENTILATION AND EVAPORATIVE EMISSION CONTROL SYSTEMS

LESSON 1: PCV SYSTEM FUNDAMENTALS AND SERVICE

I. The automotive emission control system had its beginning in the early 1960's with the introduction of PCV (positive crankcase ventilation) systems. The automotive emission control system has become one of the most important systems on today's vehicles.

A. An automobile engine produces substances such as hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). The modern automobile emission control system reduces these hydrocarbons, carbon monoxide, and oxides of nitrogen to acceptable levels before allowing them to escape into the atmosphere. In cases such as fuel tank evaporative emissions, all fuel vapors (which contain hydrocarbons) are prevented from entering the atmosphere.

B. Hydrocarbons are particles of fuel that have not completely burned. Incomplete combustion in the engine results in particles of unburned fuel entering the exhaust. Hydrocarbons are also produced as a result of the evaporation of fuel in the tank and carburetor.

C. Carbon monoxide results from incomplete combustion due to insufficient oxygen in the air/fuel mixture. Usually, the lower the carbon monoxide reading on an exhaust gas analyzer, the leaner the air/fuel mixture.

D. Nitrogen is produced normally during combustion. The higher the combustion temperature, the higher the output.

II. A positive crankcase ventilation system consists of a flow control valve and connecting hoses. The purpose of this system is to vent crankcase pressure without allowing it to escape into the atmosphere.

A. Normal combustion in the engine forces some of the combustion gases past the piston rings and into the crankcase. These gases, which are referred to as "blow-by" gases, must be vented to prevent excessive pressure from building inside the crankcase. Proper removal of blow-by also helps to prevent the buildup of sludge. Sludge buildup occurs when the gases combine with engine oil and condensation.

B. Early automobiles used a pipe called a road draft tube, which was connected directly to the crankcase. The blow-by gases were vented directly to the atmosphere through this tube.

C. Modern automobiles use a PCV system.

1. The PCV system seals the crankcase from the atmosphere and vents the blow-by gases internally.

2. A continuous flow of air through the crankcase provides positive crankcase ventilation; therefore, the system is called the positive crankcase ventilation (PCV) system.

3. The PCV system recirculates blow-by gases from the crankcase and draws them into the intake manifold. The gases are then drawn into the cylinders where they are reburned during combustion.

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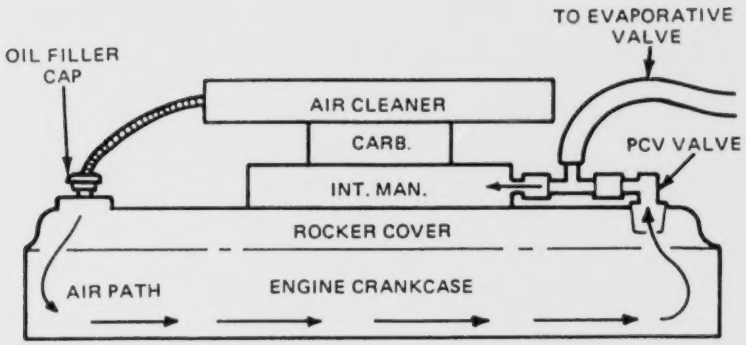


(NOTE: The gases that make up the blow-by gases are hydrocarbons, carbon monoxide, and oxides of nitrogen.)

III. PCV system construction

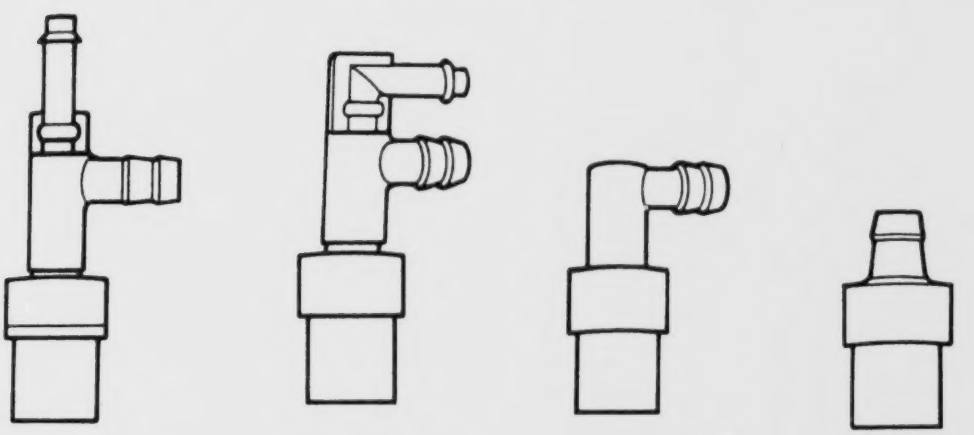
(NOTE: The PCV system is probably the simplest emission control system on a vehicle.)

A. The PCV

1. The PCV valve controls the flow of gases from the crankcase to the intake manifold. The PCV valve consists of a metal or plastic housing, which encloses a tapered plunger. The plunger is spring loaded and is normally in the closed position.

2. Crankcase pressure can overcome the spring pressure and force gases through the valve to the intake manifold; but pressure in the intake manifold cannot flow to the crankcase. The spring closes the plunger, which blocks flow. In the case of backfire in the intake manifold, the PCV valve plunger will close. This reduces the chance that a backfire will ignite crankcase vapors.

3. The PCV valve is normally mounted in a rubber grommet in the engine valve cover



B. The crankcase filter

1. Fresh air is drawn into the crankcase by engine vacuum acting on the PCV system. A filter is commonly used to remove contaminants from the incoming air. The filter also blocks the entry of oil into the air cleaner during heavy operation or excessive blow-by.

2. The filter is normally located inside the air cleaner housing. The filter may also be attached to the valve cover of the engine with a hose running to the air cleaner. Early PCV systems had a filter inside the oil filler cap; this filter removed contaminants from incoming air as it was drawn into the crankcase through the oil filler cap. In these early systems, the vapors were not completely sealed from the atmosphere.

C. Vacuum hose(s)

1. A vacuum hose is used to connect the PCV valve to the intake manifold. In some applications, the PCV valve is located "in-line" between two hose sections. One hose is connected to the intake and the other to the crankcase.

2. A hose also connects the inlet filter to the crankcase.

IV. PCV operation

A. Low pressure (vacuum) in the crankcase is created when the piston moves in the cylinders. This low pressure causes airflow through the inlet filter and into the crankcase. This incoming air replaces the crankcase gases that are drawn into the intake manifold through the PCV valve.

B. The PCV system works any time that the engine is running. However, the amount of flow varies with engine load.

V. PCV valve flow

A. Idle and low speed, light throttle operation

1. At idle and low speeds, intake manifold vacuum is very high. Crankcase pressure on one side and engine vacuum on the other work to overcome spring pressure. This opens the PCV valve, which allows the blow-by gases to flow through the valve and into the engine cylinders.

2. The amount of flow is regulated by the calibrated spring.

(NOTE: PCV valves are designed for specific applications. Do not interchange PCV valves from one type of engine to another even though the physical size of the valves may be the same. Doing so can affect engine performance.)

B. Heavy acceleration and high speed

1. During heavy acceleration, intake vacuum pressure and crankcase pressure decrease. Flow through the PCV valve is reduced.

2. During heavy acceleration, most crankcase vapors will flow out of the crankcase and into the intake through the PCV filter and air cleaner. A small amount of vapor will flow past the PCV valve and into the intake.

VI. Procedure for inspecting the PCV system

A. Visually inspect the items listed below.

1. Inspect the condition of PCV hoses. Replace any cracked, deteriorated, or missing hoses.

2. Inspect the condition of the PCV filter. If dirty, the filter should be replaced. An oil-soaked filter indicates that the PCV system is not functioning properly or that the engine has excessive blow-by.

3. Inspect the condition of the rubber mounting grommet for the PCV valve. Replace the valve if cracked, split, or missing.

B. Check PCV operation

1. Start engine and remove PCV valve from the crankcase.

2. Place finger over the open end of the valve and feel for engine vacuum. Listen for hissing sound from valve. If vacuum is not present at the valve, check for a blockage in the hose or intake manifold. If vacuum is present at the hose, replace the PCV valve.

3. With the engine off, remove the PCV valve and shake it. The valve should rattle; if not, replace the valve.

(NOTE: Before replacing a PCV valve because it fails to rattle, check an appropriate service manual or compare the old valve with a new one. Some valves may not rattle.)

VII. Servicing the PCV system

(NOTE: To maintain adequate crankcase ventilation, the PCV valve and filter must be serviced at regular intervals.)

A. Procedure for replacing the filter

1. Remove air cleaner lid.

2. Remove hose connecting filter to crankcase.

3. Remove filter retaining clip and filter.

4. Install filter in reverse order of removal.

B. Procedure for replacing PCV valve

1. Disconnect hose from PCV valve.

2. Using a twisting motion, pull the PCV valve from its mounting grommet.

3. Replace valve in reverse order of removal.

4. Replace connecting hose or grommet if defective.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PCV SYSTEMS

Instructions: Do the following tasks and answer the following questions. Write all responses on this sheet.

1. List the three gases controlled by the PCV system.

2. What valve controls the flow of blow-by gases into the intake manifold?

3. What does the PCV system prevent?

4. Extracting crankcase blow-by gases helps to prevent what problem in the crankcase?

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PCV SYSTEMS

(ANSWER SHEET)

1. Hydrocarbons, oxides of nitrogen, carbon monoxide
2. The PCV valve
3. The escape of blow-by gases to the atmosphere
4. The buildup of sludge

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

DIAGNOSING AND SERVICING THE PCV

Equipment:

Serviceable vehicle
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Visually inspect the PCV system and record results below. — — — —

   a. Hoses

      OK_____ NOT OK_____

   b. Crankcase filter

      OK_____ NOT OK_____

   c. PCV valve grommet

      OK_____ NOT OK_____

3. Connect exhaust ventilation equipment to vehicle and start engine. Check PCV operation and record results in the spaces below. — — — —

   (**CAUTION:** Be sure to use approved exhaust ventilation equipment when operating a vehicle in an enclosed area.)

   a. Was vacuum noted at the end of PCV valve?

      YES_____ NO_____

   b. Shut off engine.

   c. If "NO" was marked for item "a" above, determine the problem and place a check mark beside the source of the problem.

      PCV valve defective_____

      Hose broken_____

      Hose collapsed_____

      Blockage in intake manifold_____

4. Remove and shake PCV valve. Does it rattle? — — — —

   YES_____ NO_____

(NOTE: Before replacing a PCV valve because it does not rattle, check an appropriate service manual or compare the old valve with a new one. Some valves are not designed to rattle.)

5. Replace all defective parts as directed by the instructor. — — — —

*Average of above evaluations — — — —

(*This average is a partial evaluation for Competency L1. This average is also the final evaluation for Competency L2. Final evaluation for L1 will be made at the end of JS2-L2-UV.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT I: POSITIVE CRANKCASE VENTILATION AND EVAPORATIVE EMISSION CONTROL SYSTEMS

LESSON 2: CONSTRUCTION AND OPERATION OF EVAPORATIVE EMISSION CONTROL SYSTEMS

I. Evaporative emissions are unburned fuel (hydrocarbons) that vaporize and escape into the atmosphere. The sources of evaporative emissions in an automobile are the fuel tank and the carburetor. This lesson will deal with evaporative emission control systems, which prevent the escape of unburned hydrocarbons into the atmosphere.

A. The evaporative emission control system consists of a fuel tank that is vented to a canister filled with charcoal and then vented to the atmosphere.

B. The carburetor bowl is also vented through the charcoal canister.

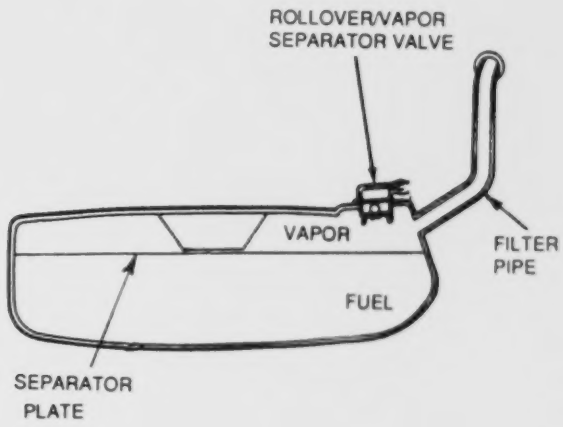
C. The charcoal canister stores the vapors until the engine is started. When the engine is started, the stored vapors are drawn out (purged) from the canister by manifold vacuum and burned in the engine.

II. Most fuel tanks have a fuel expansion area that traps vapors and prevents them from escaping into the atmosphere. As its name implies, the expansion area also allows for expansion and contraction of the fuel, which may occur as a result of temperature changes. This allowance for contraction and expansion prevents the overflow of fuel.

A. During fueling, the cold fuel pumped out of underground tanks enters the vehicle fuel tank. The warmer outside temperature causes the fuel to expand and evaporate. Hot vehicle exhaust may also cause expansion and evaporation of the fuel.

B. The fuel tank top may have a domed or bubble shape. An overfill limiter tube prevents fuel from filling this space.

C. In another design, the fuel tank contains an inner ceiling or separator inside the tank.



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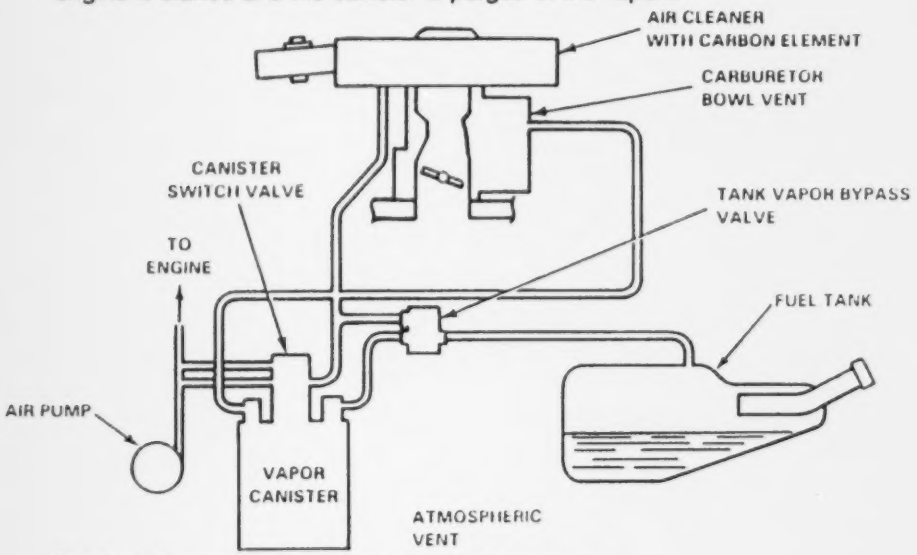
1. The separator contains an orifice that allows fuel vapor to enter the expansion volume.

2. The orifice allows expanding fuel vapor to flow into the expansion volume until the fuel level reaches the orifice. The restriction then causes a back pressure in the fuel filler tube, which cuts off the fuel fill nozzle flow.

3. The volume of air above the separator prevents overfilling.

D. Excessive fuel vapors leave the fuel tank and travel through a line to a charcoal canister, which is normally located at the front of the vehicle. The vapors are stored there until the engine is started and the canister is purged of the vapors.



E. The fuel filler cap is a pressure-vacuum type cap.

1. The fuel filler cap holds a slight pressure on the fuel tank. The pressure occurs from normal fuel heat expansion.

2. By raising tank pressure, fuel evaporation temperature is raised. This rise in temperature reduces emissions.

3. When pressure in the tank exceeds a preset limit, a valve in the cap will open and vent to the atmosphere.

4. When vacuum in the tank exceeds a preset specification, a valve in the cap opens, allowing in atmospheric pressure. This occurs during normal fuel pump operation and during contraction of the fuel as it cools.

III. Charcoal canister

A. The charcoal canister is the storage compartment for fuel vapors that have escaped the carburetor fuel bowl and the fuel tank. Fuel vapors tend to cling to the charcoal inside the canister. When air passes over the charcoal, the vapors are removed. This process is called purging.

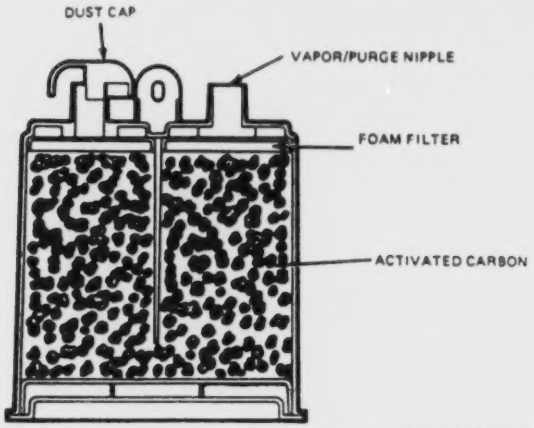
B. The canister consists of a plastic container that is filled with charcoal. The canister may or may not have an open bottom. Open-bottom canisters draw air in from the bottom and have a replaceable filter in the air inlet. On top of the canister are several hose connectors (the number of connectors varies with design).

1. One hose goes to the carburetor bowl.

2. Another hose goes to the fuel tank vent.

3. One hose will go to the intake.

4. Sometimes two canisters are used for extra storage capacity--usually when an extra large fuel tank or two fuel tanks are used. A hose connects the two canisters in series.



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IV. Carburetor fuel bowl vent

A. Carburetors must be vented in order to function properly. Atmospheric pressure must reach the float bowl to force fuel out of the idle ports and main metering nozzles as the engine runs.

B. On many older vehicles, when the engine is turned off, heat from the engine will vaporize the fuel in the carburetor float bowl, causing the fuel to escape through the bowl vent to the atmosphere. Below is a description of this process as it took place in older vehicles.

1. An external bowl vent allowed fuel vapors to enter the atmosphere directly when the engine was shut off or at idle.

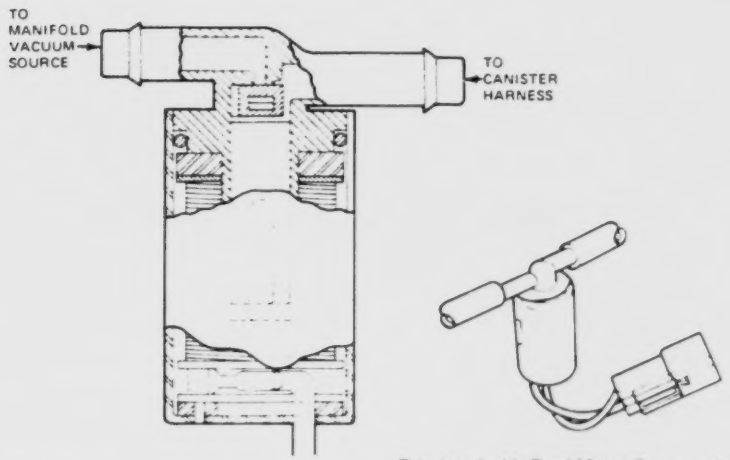
2. As the throttle opened, a mechanical linkage closed the external vent; then, an internal vent took over and vented the float bowl from inside the air filter element. This compensated for changes in atmospheric pressure due to clogged air filters and other problems.

3. However, the problem with this system was that hydrocarbon vapors were escaping into the atmosphere when the engine was shut off. Newer vehicles (those with carburetors) use a carburetor bowl vent valve to vent fuel vapors to the charcoal canister when the engine is turned off.

C. Carburetor bowl vent valves were added to many vehicles in the early 1970's. These valves may be controlled either mechanically or electrically or by air pressure or vacuum.

1. Many newer cars use an electrical solenoid controlled bowl vent valve. With the ignition off, a spring inside the solenoid valve opens the valve and allows the bowl to vent to the canister. When the ignition is turned on, the solenoid closes the valve against spring pressure. This shuts the external bowl vent and the carburetor bowl vents internally.

(NOTE: On vehicles with fuel injection, only the fuel tank is vented to the charcoal canister.)



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2. Another type of bowl vent valve is the pressure-actuated type. This type of valve is normally open, allowing the carburetor bowl to vent to the canister. When the engine is started, air pressure from the air injection pump closes a bowl vent valve.

3. The vacuum-operated bowl vent valve operates by closing the bowl vent to the canister when the engine is started. When the engine is started, intake vacuum acting on a diaphragm closes the valve. When the engine is off, spring pressure forces the valve open, venting the carburetor vapors to the canister.

V. Charcoal canister purge control

A. As was stated earlier, the charcoal canister is purged of fuel vapors when the engine is running. There are several methods of controlling canister purge, some of which are discussed below.

B. Purge operation (vacuum-operated purge)

(NOTE: The following is a general description of what takes place during canister purge in a vacuum-controlled purge valve system.)

1. A vacuum-operated canister purge valve is mounted on the charcoal canister or in-line between the canister and engine.

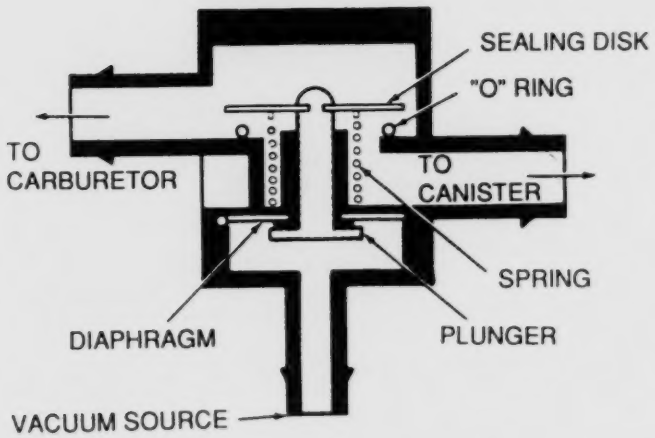
2. When the engine is started, vacuum is delivered to the purge valve. A diaphragm inside the valve moves against spring pressure, causing the purge valve to open.

3. Opening of the purge valve allows intake manifold vacuum to draw vapors from the charcoal canister as fresh air enters the canister through the air inlet/filter. The intake manifold vacuum pulls the vapors into the engine to be burned along with the normal air/fuel mixture.

4. On some vehicles, the vacuum signal, which activates the purge valve, is a ported vacuum signal.

   a. A ported vacuum signal does not occur until the throttle is opened.

   b. The ported vacuum connector is positioned above the throttle valve on the carburetor or throttle body and is not exposed to manifold vacuum until the throttle begins to open.



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C. Canister purge (solenoid purge valve)

1. The canister purge system consists of an electrical solenoid valve that controls the purging of the charcoal canister.

2. The valve is turned on and off by the ECM.

3. The valve may purge when energized or de-energized, depending on system design.

4. Some purge solenoids are pulse width modulated (turned on and off several times a second) by the ECM. The duty cycle (pulse width) is determined by sensor input to the ECM.

D. Canister purge (pressure purging)

1. Some models use output from the air injection pump to purge the canister.

2. The air output to the purge valve is controlled by a coolant control and vacuum switch.

3. When the engine is cold, there is no airflow and thus no purge. When the coolant vacuum switch reaches a specified temperature, a valve opens and applies vacuum to the air injection system air switching valve.

4. The air switching valve directs air from the air pump through a line to the canister.

5. Initially the airflow is delayed by an internal canister valve. The delay prevents an overly rich mixture from reaching the engine. The overly rich mixture may be caused by a surge or hesitation of the engine.

6. After the delay, air injection air blows through the canister, forcing fuel vapors from the charcoal into the air cleaner. The vapors flow through the carburetor and are burned in the cylinder. This system requires a closed-bottom canister.

E. Thermostatic vacuum switch

1. A thermostatic vacuum switch is used with some vacuum purge systems to prevent the canister from purging until the engine reaches a specific temperature.

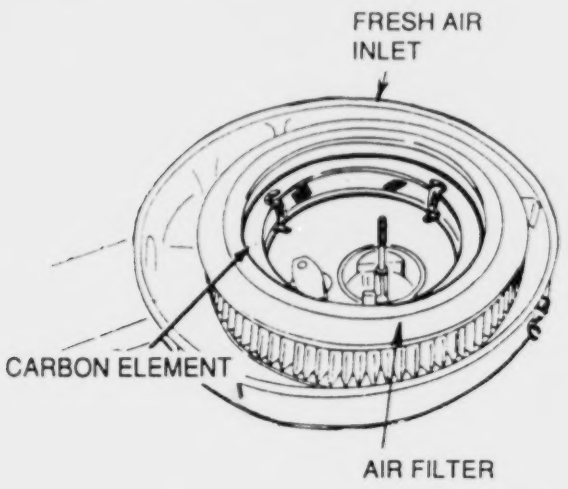
2. When a calibrated temperature is reached, the valve opens, allowing vacuum from the carburetor ported connection to reach the purge valve.

VI. Carbon element air cleaner

A. Some vehicles have an air filter that is impregnated with carbon. This type of air filter has a size and shape similar to other air filters but has a grey filtering material. This type of filter looks dirty even when new. The charcoal absorbs carburetor fuel vapors during "hot soak." When the engine restarts, the vapors flow into the carburetor for burning.

(NOTE: "Hot soak" refers to the vaporizing of the fuel in the float bowl after the engine is shut off. The vapors then flow into the carburetor throat and intake manifold, causing a flooding condition. Vaporization occurs due to the engine heating the fuel bowl.)

B. Other vehicles have a carbon ring inside the main air filter element. This ring operates in the same manner as the filter described above.



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MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

CONSTRUCTION AND OPERATION OF EVAPORATIVE EMISSION CONTROL SYSTEMS

Instructions: Do the following tasks and answer the following questions. Write all responses on this sheet.

1. What are the two sources of evaporative emissions in an automobile?

2. What device stores fuel vapors that escape from the fuel tank and carburetor?

3. What device on the carburetor bowl controls the escape of vapors from the carburetor float bowl?

4. What term refers to the process of extracting fuel vapors from the canister when the engine is started?

5. List four ways the bowl vent valve may be controlled.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

CONSTRUCTION AND OPERATION OF EVAPORATIVE EMISSION CONTROL SYSTEMS

(ANSWER SHEET)

1. Fuel tank, carburetor
2. The charcoal canister
3. The carburetor bowl vent valve
4. Purging
5. Vacuum, air pressure, electric signal, mechanical linkage

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT I: POSITIVE CRANKCASE VENTILATION AND EVAPORATIVE EMISSION CONTROL SYSTEMS

LESSON 3: SERVICING EVAPORATIVE EMISSION CONTROL SYSTEMS

I. Procedure for inspecting evaporative emission control systems

A. Inspect fuel filler cap.

1. Remove cap and make sure that it is a pressure/vent type cap.

2. Inspect the condition of cap. Replace if broken, cracked or damaged.

3. Check the condition of seal (gasket) between cap and filler neck.

B. Inspect vent lines.

1. Raise vehicle on a hoist or support it with safety stands.

2. Inspect the condition of vent line from tank to canister. Replace broken, cracked or missing lines.

3. If accessible, inspect the condition of roll-over valve.

C. Inspect charcoal canister.

1. Lower vehicle and raise hood for canister inspection.

(NOTE: The canister is generally located in the engine compartment. See service manual for exact location.)

2. Look for signs of damage to the canister, such as a broken or cracked case.

3. If canister is the open bottom type, check the condition of filter.

a. Remove hoses connecting to the canister. Mark hose position with masking tape or similar method to ensure proper reassembly.

b. Remove canister mounting and remove canister from vehicle.

c. Turn canister over and inspect filter.

d. Replace if dirty by sliding old filter from its place in the canister and inserting a new filter.

D. Canister purge control valve (vacuum)

(NOTE: The procedure described below is for a particular type of vacuum-operated bowl vent. Consult the appropriate service manual when working with a specific vehicle.)

1. Inspect valve for any signs of physical damage.

2. Remove hose at intake manifold vacuum connection of purge valve.

a. Attach a length of hose to the connector.

b. Attempt to blow through the hose. Little or no air should pass into the canister.

(NOTE: A small amount of air may pass because the canister may have a small constant purge hole.)

3. Remove hose at canister purge control vacuum port.

a. With a hand vacuum pump, apply 15" Hg vacuum at the canister purge control vacuum port.

b. The diaphragm should hold vacuum for at least 20 seconds. If the diaphragm fails to do so, the valve/canister must be replaced.

c. If the diaphragm holds vacuum, again try to blow through the hose connected to the intake manifold vacuum connection while vacuum is still applied.

d. If more air can now be blown through the valve, it is working as it should. If airflow does not increase, replace the valve/canister.

E. Carburetor bowl vent valve testing

(NOTE: Test procedures will vary, depending on the type of bowl vent valve used. Consult the appropriate service manual for specific instructions.)

1. Remove hose at canister going to carburetor bowl vent.

2. With the engine off, blow into the hose. Air should flow freely into the carburetor. If airflow is blocked, check hose condition and bowl vent valve for sticking.

3. Start and accelerate engine. Blow again through the hose.

a. The valve should now be closed and very little air should flow.

b. If air still flows into carburetor, the valve is not functioning properly.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PROCEDURE FOR TESTING EVAPORATIVE EMISSION CONTROL SYSTEM PERFORMANCE

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, engine size, and year of the vehicle to be serviced.
2. Develop a written procedure for testing the operation of the canister purge valve.
3. Develop a written procedure for testing the carburetor bowl vent valve.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING EVAPORATIVE EMISSION CONTROL SYSTEM PERFORMANCE

Equipment:

Serviceable vehicle
Hand tools
Special tools as outlined in assignment sheet
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Perform a visual inspection of the evaporative emission control system. Record the results of the inspection in the spaces provided below. — — — —

   (**CAUTION**: Part of this inspection must be done from under the vehicle. Raise the vehicle on a hoist or secure it with safety stands during that part of the procedure.)

   a. Fuel filler cap

      OK_____ NOT OK_____

   b. Vent line(s)

      OK_____ NOT OK_____

   c. Charcoal canister

      OK_____ NOT OK_____

   d. Canister filter (open bottom canister only)

      OK_____ NOT OK_____

3. Complete AS1-L3-UI. Following the procedure developed in item 2 of AS1-L3-UI, test the operation of the canister purge valve. Record the results of the test in the spaces provided below. — — — —

   a. Does the valve function as it should?

      YES_____ NO_____

   b. If "NO" was the answer to the question in item a, explain the problem and outline the proper repair procedures below.

JS1-L3-UI

4. Following the procedure developed in item 3 of AS1-L3-UI, test the operation of the carburetor bowl vent valve. Record the results of the test in the spaces provided below. _ _ _ _

   a. Does the bowl vent valve function as it should?

      YES_____ NO_____

   b. If "NO" was the answer to the question in item a, explain the problem and outline the proper repair procedures below.

5. Based on the above tests, what is the condition of the evaporative emission control system? Record the results of the test in the spaces provided below. _ _ _ _

*Average of above evaluations _ _ _ _

(*This average is a partial evaluation for Competency L1 and the final evaluation for Competency L9. Final evaluation for L1 will be made at the end of JS2-L2-UV.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT I: POSITIVE CRANKCASE VENTILATION AND EVAPORATIVE EMISSION CONTROL SYSTEMS

UNIT I TEST

PART I. DIAGNOSING AND REPAIRING EMISSION CONTROL SYSTEMS

SECTION A. Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.

____ 1. Modern emission control systems control hydrocarbons, carbon monoxide, and oxides of nitrogen.

____ 2. The higher the combustion temperature, the higher the output of oxides of nitrogen.

____ 3. The PCV system seals the crankcase and vents the blow-by gases internally.

____ 4. The PCV system is probably the most complicated emission control system on a vehicle.

____ 5. Fuel tanks can allow fumes to enter the atmosphere.

SECTION B. Read each of the below statements made by Technicians I and II. Indicate which technician is correct by placing the appropriate letter in the blank beside each question.

____ 6. TECHNICIAN I says that hydrocarbons are particles of fuel that have not been completely burned.

TECHNICIAN II says that carbon monoxide results from incomplete combustion due to insufficient fuel in the air/fuel ratio.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 7. TECHNICIAN I says that the PCV system helps prevent sludge buildup inside the engine.

TECHNICIAN II says that the PCV system recirculates blow-by gases so that they are reburned during combustion.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 8. TECHNICIAN I says that PCV systems use a filter to clean the air coming into the crankcase.

TECHNICIAN II says that the PCV valve allows its greatest flow during idle.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

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___ 9. TECHNICIAN I says that, if a PCV valve will fit in the grommet, it is the correct unit.

TECHNICIAN II says that automotive emission control systems had their beginning in the early 1960's.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 10. TECHNICIAN I says that on new vehicles the ECM controls PCV valve operation.

TECHNICIAN II says that the PCV valve is open during heavy acceleration.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

(NOTE: The student must obtain a minimum score of ____ on Part I of the Unit I Test in order to receive an evaluation for Competencies L1 and L2.)

PART II. INSPECTING AND REPLACING PCV SYSTEM COMPONENTS

SECTION A. Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.

___ 11. The PCV valve can be inspected while it is still in the engine.

___ 12. A PCV valve should rattle if it is in good condition.

___ 13. Part of the PCV valve inspection process involves checking all the hoses of the system.

___ 14. The PCV valve should have vacuum present during idle.

___ 15. If no vacuum is present at the PCV valve, replace the valve.

___ 16. The PCV valve and filter should only be changed if a problem is suspected.

___ 17. On newer vehicles the PCV filter is usually found in the air filter.

___ 18. Most PCV filters are removed by removing the screws that hold them in place.

___ 19. PCV valves are usually pressed in and out of their locations.

___ 20. Most PCV valves should be removed and replaced on a regular interval.

(NOTE: The student must obtain a minimum score of ____ on Part II of the Unit I Test in order to receive an evaluation for Competency L2.)

PART III: SERVICING FUEL VAPOR CONTROL SYSTEMS

SECTION A: Read each of the below statements made by Technicians I and II. Indicate which technician is correct by placing the appropriate letter in the blank beside each question.

___ 21. TECHNICIAN I says that, during an inspection of the filler cap (gas cap), it is important to make sure that the vehicle has the proper type of cap.

TECHNICIAN II says that any damage to the filler cap, gasket, or filler neck will make it necessary to replace the filler cap.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 22. TECHNICIAN I says that, in order to check evaporate emission control system vent lines, the vehicle will need to be raised and supported.

TECHNICIAN II says that the filter on an open bottom charcoal canister should be inspected when the evaporative emission control systems are inspected.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 23. TECHNICIAN I says that vacuum lines should be marked for proper installation during repairs to the charcoal canister.

TECHNICIAN II says that a vacuum canister purge valve should hold 20" Hg vacuum for 10 seconds.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 24. TECHNICIAN I says that generally the carburetor bowl vent should be open when the engine is not running.

TECHNICIAN II says that generally the carburetor bowl vent should be open when the engine is at full throttle.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 25. TECHNICIAN I says that when vacuum is applied to a vacuum-operated canister purge valve, the valve should close.

TECHNICIAN II says that when vacuum is applied to a vacuum-operated canister purge valve, the valve should close only partially.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

(NOTE: The student must obtain a minimum score of ____ on Part III of the Unit I Test in order to receive an evaluation for Competency L9.)

ANSWERS TO UNIT I TEST

1. f
2. t
3. t
4. f
5. f
6. a
7. c
8. c
9. b
10. d
11. f
12. f
13. t
14. t
15. f
16. f
17. t
18. f
19. f
20. t
21. a
22. c
23. c
24. a
25. d

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT II: EXHAUST GAS RECIRCULATION

UNIT OBJECTIVE

After completing this unit, the student should be able to identify components of an exhaust gas recirculation system, explain the operation of the system, and diagnose and repair problems related to the system. The student will demonstrate mastery of the material by achieving a score of _____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1.

I. Identify the basic characteristics of an EGR system (Competencies L1 and L5, Unit II Test).

II. Identify the operation of a typical EGR system (Competencies L1 and L5, Unit II Test).

III. Identify the characteristics of an EGR valve (Competencies L1 and L5, Unit II Test).

IV. Identify the characteristics of an EGR shutoff solenoid and an EGR vacuum regulator solenoid (Competencies L1 and L5, Unit II Test).

Lesson 2.

I. Identify the procedure for testing an EGR system (Competency L5, Part II of the Unit II Test).

II. Identify the procedure for removing and installing an EGR valve (Competency L5, Part II of the Unit II Test).

III. Demonstrate the ability to:

a. Diagnose the EGR system (Competencies L1 and L5, JS1-L2-UII).

b. Remove and install an EGR valve (Competency L5, JS2-L2-UII).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks H071-H074.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT II: EXHAUST GAS RECIRCULATION

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: EGR OPERATION

   a. Information outline

   b. Assignment sheet

      AS1-L1-UII: Principles of EGR Operation

2. Lesson 2: EGR SERVICE

   a. Information outline

   b. Assignment sheets

      AS1-L2-UII: Procedure for Diagnosing the EGR System
      AS2-L2-UII: Procedure for Removing and Installing the EGR Valve

   c. Job sheets

      JS1-L2-UII: Diagnosing the EGR System
      JS2-L2-UII: Removing and Installing the EGR Valve

E. Unit test

F. Answers to unit test

REFERENCES

Chrysler Corporation. Oxygen Feedback Systems. Chrysler Corporation, 1983.

Chrysler Corporation. Technical Guide, 1.4, 1.6, 2.0, and 2.6 Liter Engine Performance. Chrysler Corporation, 1982.

Chrysler Corporation. Technical Guide, 3.7/5.2 Liter Engine Performance. Chrysler Corporation, 1982.

Ford Parts and Service Division. EEC System Operation. Ford Parts and Service Division, 1986.

Ford Parts and Service Division. 1984 Car Shop Manual, Emission Diagnosis. Ford Parts and Service Division, 1983.

BEST COPY AVAILABLE

General Motors Corporation. C-4 Engine Performance. General Motors Corporation, 1980.

General Motors Corporation. 1982 Buick Skyhawk Chassis and Body Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1982 Chevrolet Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1989 R-V-G-P Light Duty Truck Service Manual, 10-30 Series. General Motors Corporation, 1988.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Students should do AS1-L1-UII before taking the Unit II test. Students should also do AS1-L2-UII in conjunction with JS1-L2-UII and AS2-L2-UII in conjunction with JS2-L2-UII.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT II: EXHAUST GAS RECIRCULATION

LESSON 1: EGR OPERATION

I. Introduction to exhaust gas recirculation (EGR)

A. When combustion chamber temperatures reach 3500 to 4000 degrees Fahrenheit, nitrogen combines with oxygen to form oxides of nitrogen (NOx). NOx is a harmful pollutant which is reduced when combustion temperatures are lowered.

B. The EGR system is used to reduce combustion chamber temperatures. The EGR system works by recirculating small amounts of exhaust gas from the exhaust system back into the combustion chambers.

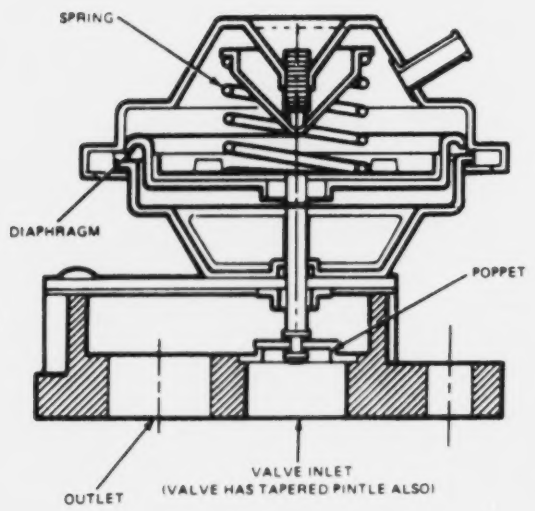
C. The spent exhaust gases reduce combustion chamber temperatures as much as 500 degrees Fahrenheit, which in turn reduces oxides of nitrogen.

II. Operation of the EGR system

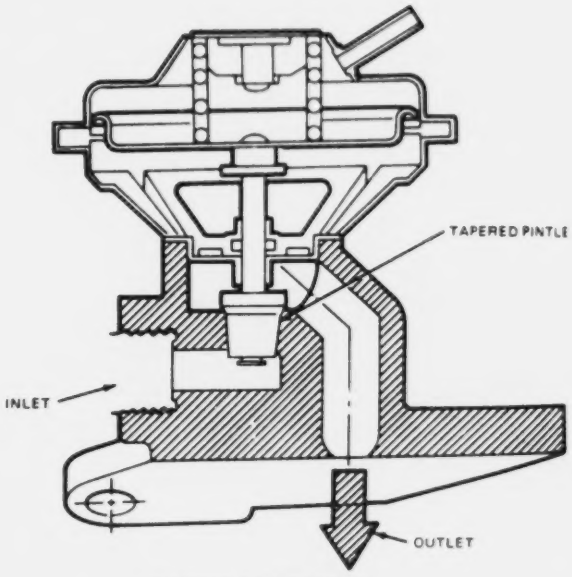
A. Either an exhaust passage in the intake manifold or an external exhaust tube carries engine exhaust to a control valve (the EGR valve).

B. The EGR valve contains a diaphragm that causes the valve orifice to open in response to engine vacuum and (in some cases) in response to vacuum and exhaust back pressure.

C. When the valve opens, exhaust from the exhaust passage is allowed to flow into the intake manifold. Maximum amount of exhaust flow is limited by a metered orifice in the valve.



BASE ENTRY, POPPET TYPE



SIDE ENTRY, TAPERED PINTLE

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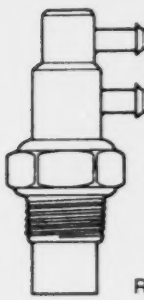
D. The EGR valve does not receive vacuum at idle. Little oxides of nitrogen is formed at idle speed; introducing exhaust gas at idle would produce poor idle and low-speed operation of the engine.

1. The vacuum line connected to the EGR valve is generally connected on the other end to a ported vacuum connector on the carburetor or throttle body.

2. A ported connector is one that is above the throttle valve and is open to vacuum only as the throttle is opened.

E. A temperature-controlled vacuum switch is used on many applications to prevent the operation of the EGR valve when the engine is cold. This improves cold engine drivability.

1. The valve consists of a coolant temperature sensor (which is exposed to engine coolant), a valve that is closed when cold, and two or more vacuum connectors.



A CONNECTS TO VACUUM DEVICE
B CONNECTS TO VACUUM SOURCE

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2. The valve is in the closed position when the engine is cold and blocks the flow of vacuum from the carburetor/throttle body to the EGR valve.

3. When engine coolant reaches a specified temperature, the valve opens and allows vacuum to reach the EGR valve.

4. Other similar valves are commonly used in other automotive emission control systems.

III. EGR valve

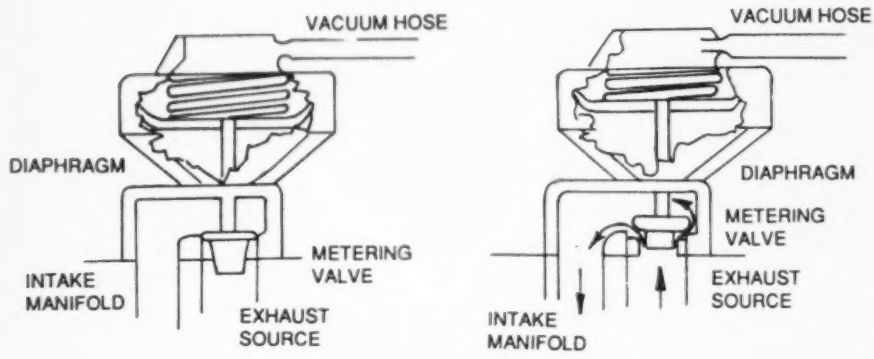
A. The EGR valve is the heart of the EGR system. The EGR valve controls the amount of exhaust gas that is recirculated back into the engine. Several different types of EGR valves are used. The simplest type is the single-diaphragm valve.

1. The single-diaphragm valve consists of a diaphragm connected to an exhaust metering valve by a metal shaft.

2. The diaphragm is spring-loaded to keep the valve closed when no vacuum is present.

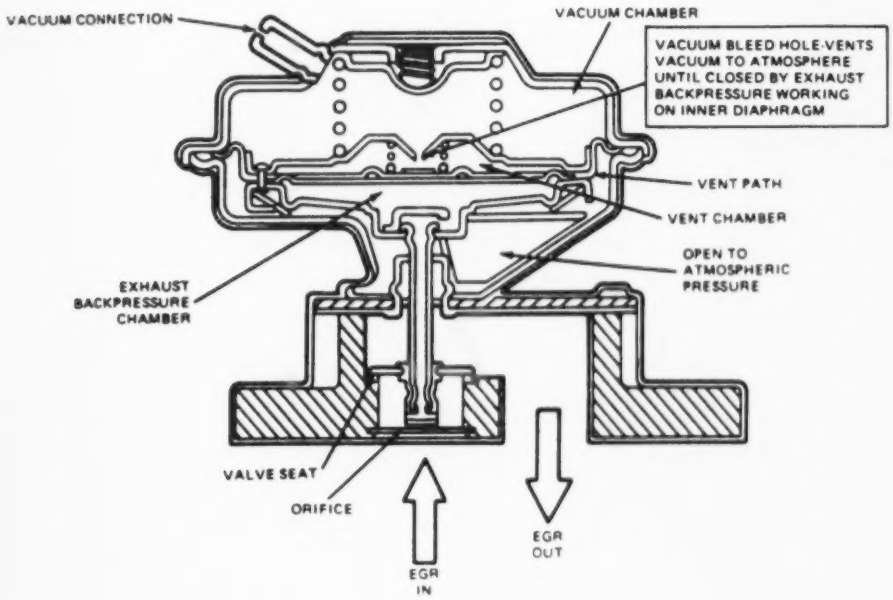
3. When the throttle valve(s) is opened and the EGR vacuum port begins to receive a vacuum signal, vacuum is applied to the EGR valve diaphragm.

4. The vacuum pulls the diaphragm up, opening the EGR valve. The amount that the EGR valve opens is governed by the strength of the vacuum signal received.



B. Positive backpressure EGR valve

1. The positive backpressure EGR valve uses both engine vacuum and exhaust backpressure to control the recirculation of exhaust gases. The valve provides more recirculation during heavy engine loads than does the single-diaphragm unit.



2. A small, diaphragm-controlled valve inside the EGR valve acts as a pressure regulator. The control valve receives an exhaust backpressure signal through a hole in the center of the valve shaft.

3. The exhaust gases put pressure on the bottom of the control valve diaphragm.

   a. A metal deflector plate prevents direct contact between the hot exhaust and the diaphragm.

   b. The diaphragm plate contains six bleed holes to bleed air into the vacuum chamber when the backpressure valve is in the controlling mode.

4. During off-idle, vacuum from the carburetor port is applied to the vacuum chamber.

   a. When engine load is light, exhaust backpressure is low, allowing the control valve to open.

   b. Air then flows through the six bleed holes in the diaphragm plate through the open control valve and into the vacuum chamber.

   c. This air bleeds off the vacuum signal to the EGR valve, thus reducing the amount of exhaust gas recirculated.

5. When power demands are made on the engine, exhaust backpressure increases, closing the control valve.

   a. Vacuum in the chamber then pulls the valve open, overcoming the spring force holding the EGR valve closed.

   b. Once the EGR valve opens, the exhaust pressure will decrease because some of the exhaust is now flowing into the intake manifold.

   c. This will decrease the amount of exhaust being recirculated.

   d. The system will eventually reach a balanced condition, providing optimum EGR.

   e. At wide-open throttle, when manifold vacuum is nearly zero, there will be no EGR. This is because there is not enough vacuum to open the valve even though the exhaust backpressure is high.

C. Negative backpressure EGR valve

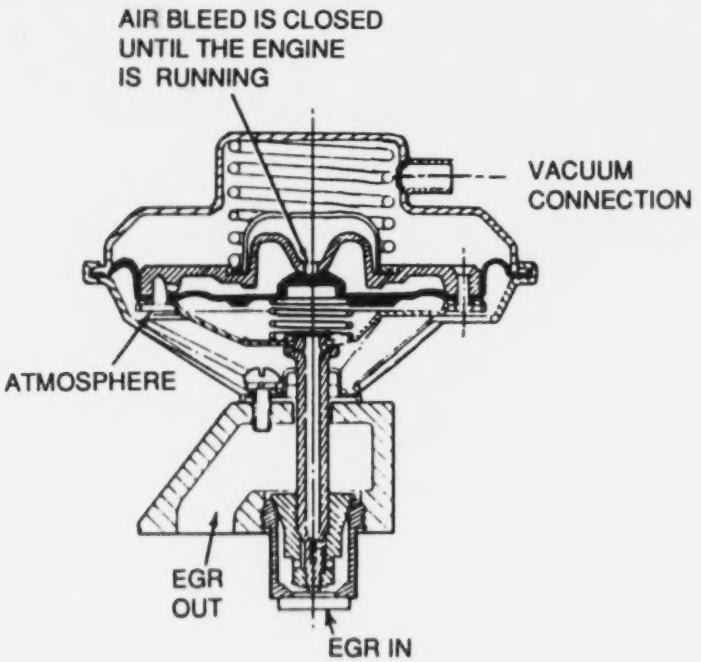
1. The negative backpressure EGR valve operates in a similar fashion to a positive backpressure EGR valve. The negative backpressure EGR valve, however, is designed to open with a negative exhaust backpressure.

2. Valve operation is controlled by manifold vacuum, negative exhaust backpressure, and the carburetor-ported vacuum signal.

3. The control valve spring is placed on the bottom side of the diaphragm instead of above it (as in the positive backpressure valve).

   a. When the carburetor-ported vacuum signal is applied to the main vacuum chamber, partially opening the valve, the vacuum signal from the manifold side (reduced by exhaust backpressure) is transmitted up the hollow stem of the valve.

b. This enables the signal to act on the diaphragm, opening the bleed and causing the valve to modulate, providing a specific flow.

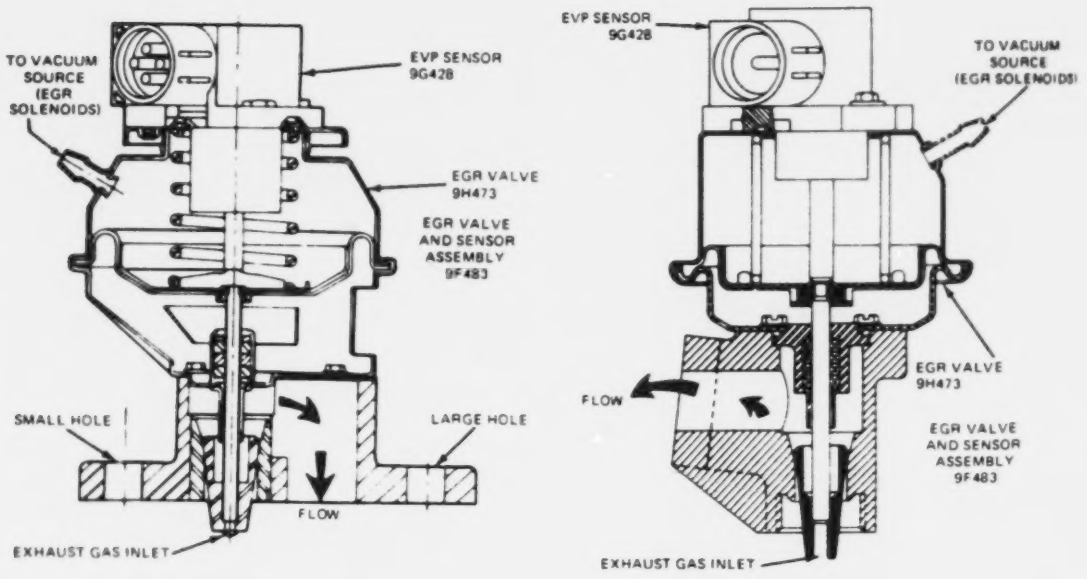


D. Electronic EGR valve assembly

1. The electronic EGR valve is used in some electronic engine control systems. The electronic EGR valve is operated by a vacuum signal from EGR solenoids, which are controlled by the engine computer.

2 As vacuum overcomes the diaphragm spring, the diaphragm begins to move, thus opening the valve and allowing exhaust gas to recirculate.

3. A sensor mounted on the EGR valve detects the amount of EGR valve movement. The sensor then sends signals to the engine computer, telling it the amount of EGR valve movement.



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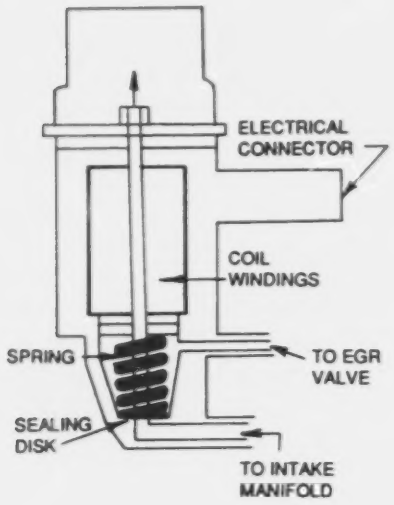
IV. Other controls include the EGR shutoff solenoid and the EGR vacuum regulator solenoid.

A. The EGR shutoff solenoid is an electrical solenoid valve that controls the flow of vacuum to the EGR valve. The EGR shutoff solenoid is placed in-line between the carburetor vacuum source and the EGR valve.

(NOTE: The EGR shutoff solenoid may be a normally open valve that is closed by the engine computer or a normally closed valve that is opened by the engine computer.)

B. The EGR vacuum regulator is a normally closed electromagnetic solenoid that controls the vacuum signal received by the EGR valve.

(NOTE: Current delivered to the vacuum regulator solenoid is increased and decreased by the engine computer, according to the desired amount of EGR opening.)



MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PRINCIPLES OF EGR OPERATION

Instructions: Do the following tasks and answer the following questions. Write all responses on this sheet.

1. EGR stands for what term?

2. The EGR is used to reduce what element in vehicle emissions?

3. Recirculating exhaust gas serves what purpose in the combustion chamber?

4. The carburetor vacuum signal received by the EGR valve is what kind of signal?

5. When does the EGR vacuum temperature control switch prevent EGR operation?

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PRINCIPLES OF EGR OPERATION

(ANSWER SHEET)

1. Exhaust gas recirculation
2. Oxides of nitrogen
3. Reduces combustion chamber temperatures
4. Ported vacuum signal
5. When the engine is cold

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT II: EXHAUST GAS RECIRCULATION

LESSON 2: EGR SERVICE

I. Testing the EGR system

(NOTE: Testing procedures for EGR systems vary considerably, depending on the type of system being serviced. The following procedures are general and apply to a system that is not electronically controlled. In addition to the standard tests described below, electronic systems can be diagnosed in part by accessing fault codes and by performing standard volt-ohmmeter tests. Procedures for fault code access and volt-ohmmeter tests can be found in the appropriate service manual.)

A. Procedure for performing a functional check of the EGR system

1. Set the parking brake and block drive wheels. Place transmission in neutral or park.

2. Connect exhaust ventilation equipment to vehicle exhaust, start engine, and bring it to operating temperature.

3. Observe or feel the bottom side of the EGR valve diaphragm.

(**CAUTION:** Use a glove or rag to protect fingers when feeling the bottom of the valve. The valve is hot and could burn bare fingers.)

a. The valve diaphragm should move upward (open) as the engine accelerates.

b. The valve diaphragm should move downward (close) as the engine returns to idle.

(NOTE: A slight vibration of the diaphragm plate may be noticed on backpressure models. This is due to the control valve modulating under light load and does not indicate a problem.)

4. If the valve diaphragm does not move, check for vacuum at the hose while engine is running at 2000 rpm.

a. If vacuum is present, replace EGR valve.

b. If there is no vacuum present, check vacuum hose for restriction.

c. If there is no restriction in the hose and the engine is thoroughly warmed up, replace EGR temperature vacuum valve, if so equipped.

B. If the EGR is suspected of causing a problem or if the EGR passages are suspected of being plugged, perform the more detailed test outlined below.

(NOTE: The below procedure may involve disconnecting the idle speed control on some computer-controlled engines.)

1. Connect a tachometer to the engine.

2. While the engine is at normal operating temperature, run the engine at 2000 rpm in neutral.

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3. Disconnect the vacuum hose from the EGR valve.

4. Engine speed should increase. If it does, the EGR valve is operating and the passages are clear.

5. If the speed does not increase, check under the valve diaphragm for movement as the hose is connected. If there is no movement and there is vacuum at the hose, replace the valve.

6. If the valve moves but the speed does not increase, remove and clean the valve. Also clean passages in the manifold.

C. Procedure for testing the EGR vacuum temperature control

1. Allow engine to cool completely, then start the engine.

2. Accelerate engine and check for vacuum at EGR valve; there should be no vacuum. If vacuum is present, check for proper vacuum hose routing. If routing is correct, replace the temperature control valve.

II. Removing and installing the EGR valve

A. Procedure for removing the EGR valve

1. Disconnect EGR valve vacuum hose at the valve.

2. Remove bolts or nuts holding the EGR valve on the manifold or adaptor.

3. Remove EGR valve and gasket from manifold or adaptor.

B. Procedure for inspecting and cleaning the EGR valve

1. Inspect the passages in the intake manifold and/or adaptor for excessive build-up of deposits.

a. Clean deposits from EGR ports by hand. Use a small drill bit and screwdriver to remove deposits from the holes and chambers.

b. Blow out passages with compressed air. Do not use solvent for cleaning.

(NOTE: Be sure to remove all loose particles. Particles that are not removed may clog the EGR valve or may be ingested by the engine.)

2. If the valve is to be re-used, inspect the EGR valve for restrictions from carbon deposits. Clean the valve according to the procedure outlined below.

a. Use a wire wheel to buff the valve's mounting surface and surrounding areas.

(NOTE: Do not wash the valve in solvent. Doing so may permanently damage the diaphragm.)

b. Hold valve assembly in hand. Using a light snapping action with a plastic hammer, tap on the end of the valve to remove exhaust deposits from the valve seat. Empty loose particles.

c. Depress the valve diaphragm and check the seating area for cleanliness by looking through the valve outlet. If valve pintles are not completely clean, repeat step "b."

(NOTE: Depending on valve design, this procedure may not be possible. Check manufacturer's service manual for instructions when working with a specific vehicle.)

C. Procedure for installing an EGR valve

1. Clean mounting surface on manifold or adaptor and install a new gasket.

2. Install valve in reverse order of disassembly and tighten bolts to manufacturer's specified torque.

3. Reconnect vacuum hose.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PROCEDURE FOR DIAGNOSING THE EGR SYSTEM

Instructions: **Do the following tasks on a separate sheet of paper.**

(HINT: Use an appropriate service manual.)

1. Record the make, model, engine size, and year of the vehicle to be serviced.

2. Develop a written procedure for diagnosing EGR system operation. Include procedure for testing electrical solenoids or vacuum switches controlling the flow of vacuum to the EGR valve.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PROCEDURE FOR REMOVING AND INSTALLING THE EGR VALVE

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, engine size, and year of the vehicle to be serviced.
2. Develop a written procedure for removal of the EGR valve.
3. Develop a written procedure for inspection and cleaning of the valve.
4. Develop a written procedure for installation of the EGR valve. Include applicable torque specifications.

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MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

DIAGNOSING THE EGR SYSTEM

Equipment:

Hand tools
Special tools as needed
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Complete AS1-L2-UII. Following the procedure developed in item 2 of AS1-L2-UII, test the performance of the EGR system. Indicate whether the items in the list are "OK" or "NOT OK." — — — —

   (NOTE: Place the letters "N/A" beside any item that is not included in the system being serviced.)

   (**CAUTION:** Be sure to use approved exhaust ventilation equipment when operating a vehicle in an enclosed area.)

   a. EGR valve operation

      OK_____ NOT OK_____

   b. EGR vacuum temperature switch

      OK_____ NOT OK_____

   c. EGR vacuum hoses and lines

      OK_____ NOT OK_____

   d. EGR solenoid

      OK_____ NOT OK_____

   e. EGR passages in intake and valve

      OK_____ NOT OK_____

   f. ECM fault codes

      OK_____ NOT OK_____

g. Other components

OK_____ NOT OK_____

3. If any of the above items was marked NOT OK, explain the problem and suggest repair procedures in the space provided below. _ _ _ _

*Average of above evaluations _ _ _ _

(*This average is a partial evaluation for Competencies L1 and L5. Final evaluation for L1 will be made at the end of JS2-L2-UV. Final evaluation for L5 will be made at the end of JS2-L2-UII.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

REMOVING AND INSTALLING THE EGR VALVE

Equipment:

Hand tools
Special tools as needed
Safety glasses

Procedure:

		Evaluation 3 2 1 N
1.	Wear safety glasses while doing all procedures on this job sheet.	— — — —
2.	Complete AS2-L2-UII. Following the procedure developed in item 2 of AS2-L2-UII, remove the EGR valve from the vehicle.	— — — —
3.	Following the procedure developed in item 3 of AS2-L2-UII, clean and inspect the EGR valve. Record results of the inspection in the space provided below.	— — — —
4.	Following the procedure outlined in item 4 of AS2-L2-UII, install the EGR valve. Connect exhaust ventilation equipment to vehicle exhaust, start engine, and bring it to operating temperature. Check EGR valve for proper operation. Record observations below.	— — — —
	*Average of above evaluations	— — — —

(*This average is a partial evaluation for Competency L5. Final evaluation for L5 will be made at the end of this job sheet.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency L5 by averaging the evaluations of JS1-L2-UII and JS2-L2-UII. Use the spaces provided below.

	Evaluation 3 2 1 N
JS1-L2-UII	— — — —
JS2-L2-UII	— — — —
Final evaluation for Competency L5	— — — —

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT II: EXHAUST GAS RECIRCULATION

UNIT II TEST

PART I. PRINCIPLES OF EGR SYSTEMS

SECTION A. Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.

____ 1. Lowering combustion temperature lowers the oxides of nitrogen content of vehicle emissions.

____ 2. If temperatures reach 400 to 500 degrees Fahrenheit, nitrogen will combine with oxygen.

____ 3. Some EGR valves use vacuum and exhaust backpressure for operation.

____ 4. The EGR shutoff solenoid and vacuum regulator solenoid perform the same basic function.

____ 5. EGR valves operate only when the engine is at normal temperature.

SECTION B. Read each of the below statements made by Technicians I and II. Indicate which technician is correct by placing the appropriate letter in the blank beside each question.

____ 6. TECHNICIAN I says that, when the EGR valve opens, exhaust gas is drawn back into the intake manifold where it is burned again.

TECHNICIAN II says that an EGR valve does not open during idle.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

____ 7. TECHNICIAN I says that a ported vacuum source only delivers vacuum when the throttle is open.

TECHNICIAN II says that ported vacuum sources are found above the throttle plates.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

____ 8. TECHNICIAN I says that a temperature control valve closes off vacuum to the EGR valve as the engine temperature increases.

TECHNICIAN II says that there are many different types of EGR valves.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 9. TECHNICIAN I says that as the throttle opens, so should the EGR valve.

TECHNICIAN II says that a positive backpressure EGR valve provides more recirculation than a single-diaphragm unit.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

___ 10. TECHNICIAN I says that the control valve spring is located in a different place in the positive backpressure EGR valve than in the negative backpressure EGR valve.

TECHNICIAN II says that an electronic EGR valve is controlled by the ECM.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

(NOTE: The student must obtain a minimum score of ____ on Part I of the Unit II Test in order to receive an evaluation for Competencies L1 and L5.)

PART II. DIAGNOSING AND REPAIRING EGR SYSTEMS

SECTION A. Read each of the below statements made by Technicians I and II. Indicate which technician is correct by placing the appropriate letter in the blank beside each question.

___ 11. TECHNICIAN I says that some EGR systems send fault codes to the ECM.

TECHNICIAN II says that care must be used when testing the EGR valve to prevent electrical shock.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

___ 12. TECHNICIAN I says that, when checking backpressure EGR valves, some vibration can be expected.

TECHNICIAN II says that, when the EGR vacuum source is disconnected, the engine speed should decrease after reaching 2,000 rpm.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

___ 13. TECHNICIAN I says that, when the engine is warm, the temperature vacuum gauge should be open.

TECHNICIAN II says that, before replacing a temperature control valve, check the vacuum hose routing to and from the valve.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

___ 14. TECHNICIAN I says that, when the engine is warm, the EGR valve should open as engine speed increases.

TECHNICIAN II says that, if an EGR valve is inoperative, the vacuum supply should be checked first.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

___ 15. TECHNICIAN I says that, if EGR passages become plugged, vacuum will be prevented from reaching the EGR valve.

TECHNICIAN II says that, if EGR passages become plugged, the flow of exhaust gases will be prevented from reaching the intake manifold.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

SECTION B. Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.

___ 16. There is a gasket between the EGR valve and its cylinder head.

___ 17. Deposits are cleaned from the EGR ports with a small chisel and a hammer.

___ 18. The EGR valve should be cleaned with solvent.

___ 19. Carbon is removed from some EGR valve seats by hitting the valve with a soft hammer.

___ 20. The mounting surface of an EGR valve should not be cleaned with a wire wheel.

(NOTE: The student must obtain a minimum score of ____ on Part II of the Unit II Test in order to receive an evaluation for Competency L5.)

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ANSWERS TO UNIT II TEST

1. t
2. f
3. t
4. t
5. t
6. c
7. c
8. b
9. c
10. a
11. a
12. a
13. c
14. c
15. b
16. f
17. f
18. f
19. t
20. f

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT III: AIR INJECTION AND CATALYTIC CONVERTERS

UNIT OBJECTIVE

After completing this unit, the student should be able to identify the components of various air injection systems and explain their operation; explain the operation of a catalytic converter; and diagnose problems related to both air injection and catalytic converters and replace system components. The student will demonstrate mastery of the material by achieving a score of _____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1.

I. Identify the components and explain the operation of the air injection system (Competencies L1 and L6, Unit III Test).

II. Identify the components and explain the operation of the air pump system (Competencies L1 and L6, Unit III Test).

III. Explain the construction and operation of the exhaust pulse type air injection system (Competencies L1 and L6, Unit III Test).

IV. Explain the construction and operation of catalytic converters (Competencies L1 and L6, Unit III Test).

Lesson 2.

I. Identify the procedures for testing the air pump injection system (Competency L6, Unit III Test).

II. Identify the procedures for replacing components of the air pump injection system (Competency L6, Unit III Test).

III. Identify the procedures for testing and servicing exhaust pulse air injection systems (Competency L6, Unit III Test).

IV. Identify the procedures for catalytic converter inspection and replacement (Competency L6, Unit III Test).

V. Demonstrate the ability to:

a. Test the performance of exhaust pulse type air injection systems (Competencies L1 and L6, JS1-L2-UIII).

b. Test the performance of air pump type air injection systems (Competencies L1 and L6, JS2-L2-UIII).

c. Inspect and replace catalytic converters (Competency L6, JS3-L2 UIII).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks H075-H082.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT III: AIR INJECTION AND CATALYTIC CONVERTERS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: CONSTRUCTION AND OPERATION OF AIR INJECTION SYSTEMS AND CATALYTIC CONVERTERS

   a. Information outline

   b. Assignment sheet

      AS1-L1-UIII: Air Injection Systems and Catalytic Converters

2. Lesson 2: AIR INJECTION AND CATALYTIC CONVERTER DIAGNOSIS AND REPAIR

   a. Information outline

   b. Assignment sheet

      AS1-L2-UIII: Procedure for Removing and Installing a Catalytic Converter

   c. Job sheets

      JS1-L2-UIII: Testing the Performance of an Exhaust Pulse Type Air Injection System
      JS2-L2-UIII: Testing the Performance of an Air Pump Type Air Injection System
      JS3-L2-UIII: Removing and Installing the Catalytic Converter

E. Unit test

F. Answers to unit test

REFERENCES

Chrysler Corporation. Oxygen Feedback Systems. Chrysler Corporation, 1983.

Chrysler Corporation. Technical Guide, 1.4, 1.6, 2.0, and 2.6 Liter Engine Performance. Chrysler Corporation, 1982.

Chrysler Corporation. Technical Guide, 3.7/5.2 Liter Engine Performance. Chrysler Corporation, 1982.

Ford Parts and Service Division. EEC System Operation. Ford Parts and Service Division, 1986.

Ford Parts and Service Division. 1984 Car Shop Manual, Emission Diagnosis. Ford Parts and Service Division, 1983.

General Motors Corporation. C-4 Engine Performance. General Motors Corporation, 1980.

General Motors Corporation. 1982 Buick Skyhawk Chassis and Body Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1982 Chevrolet Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1989 R-V-G-P Light Duty Truck Service Manual, 10-30 Series. General Motors Corporation, 1988.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Students should do AS1-L2-UIII in conjunction with JS3 L2-UIII.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT III: AIR INJECTION AND CATALYTIC CONVERTERS

LESSON 1: CONSTRUCTION AND OPERATION OF AIR INJECTION SYSTEMS AND CATALYTIC CONVERTERS

I. Introduction to air injection

A. The air injection system is designed to reduce the amount of hydrocarbons (HC) and carbon monoxide (CO) that comes out of a vehicle tail pipe.

B. The air injection system forces air into either the engine exhaust ports, or the catalytic converter, or both. Air is forced into these areas at different times, depending on system design.

C. Unburned fuel vapors are still present after combustion has occurred within the engine cylinders. Though the exhaust is hot enough to burn the remaining fuel vapors, there is not enough oxygen to do so. Air injection provides the oxygen necessary to burn the remaining fuel vapors. This allows the engine to run with a slightly richer air/fuel mixture for better performance while reducing the amount of unburned fuel vapors (which contain hydrocarbons and carbon monoxide) in vehicle emissions.

D. An air injection system also provides the oxygen needed to start the oxidation process in the catalytic converter. The oxidation process improves the efficiency of the catalytic converter.

(NOTE: Oxidation refers to the process of introducing oxygen into a chemical reaction.)

E. Air injection is also used on vehicles with an exhaust oxygen sensor. On these vehicles, however, the injection of oxygen is routed away from (downstream of) the sensor during feedback operation. This prevents air injection from causing false exhaust oxygen content readings.

F. Air injection is usually achieved through the use of a belt-driven air pump and connecting tubing and valves. Some systems rely on exhaust pulses or crankcase pressure pulses to force air into the engine exhaust.

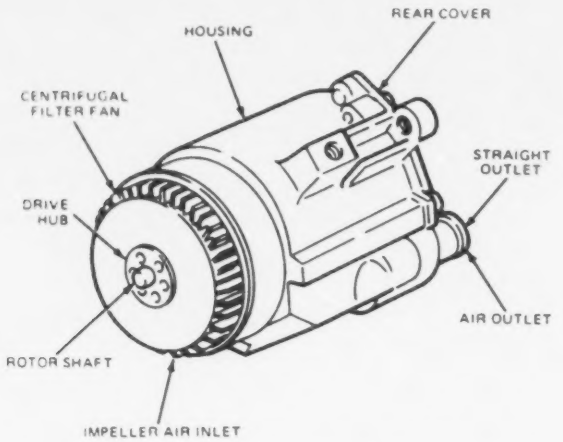
II. Air pump systems

A. Air pump

1. The air pump in an air injection system is usually a belt-driven, positive-displacement vane pump. This pump is a high-volume, low-pressure pump, which produces a maximum pressure of about 5 psi.

2. Air enters the pump through a centrifugal filter fan at the front. The rotating action of the filter fan spins dirt particles in the air, which expels the dirt particles by centrifugal force. This purifies air injection to the exhaust.

3. The pump requires no lubrication and, with the exception of the filter, is not serviceable. Hoses and metal tubes carry the air from the pump to the vehicle exhaust.



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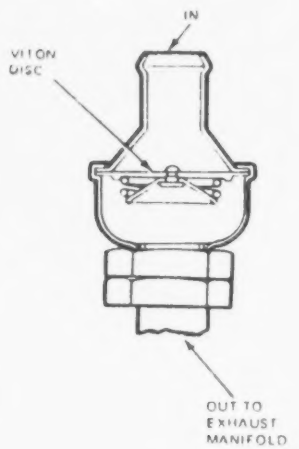
B. Check valves

1. A check valve is located in each injection tube, which leads to each exhaust manifold and catalyst injection point. The valves have a one-way diaphragm that allows air from the pump to enter the exhaust stream but prevents hot exhaust gases from backing up into the hose and pump.

2. The check valves protect the system in case of a pump failure, a break in the pump belt, a ruptured hose, or an abnormally high exhaust backpressure.



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C. Diverter valve

1. The diverter valve is a device that controls the flow of air from the air pump. The valve prevents a backfire in the exhaust during deceleration. In order to do this, the valve diverts air that would normally be pumped into the vehicle exhaust to the atmosphere or to the vehicle air cleaner.

2. The diverter valve commonly consists of a vacuum diaphragm, pressure relief valve, two ports and a control valve, and sometimes a bypass area containing silencer material.

   a. The control valve and diaphragm are normally spring-loaded in order to open the port to the exhaust.

   b. When the engine starts, intake vacuum partially raises the diaphragm and valve This allows air from the air pump to flow through the valve and to the engine exhaust.

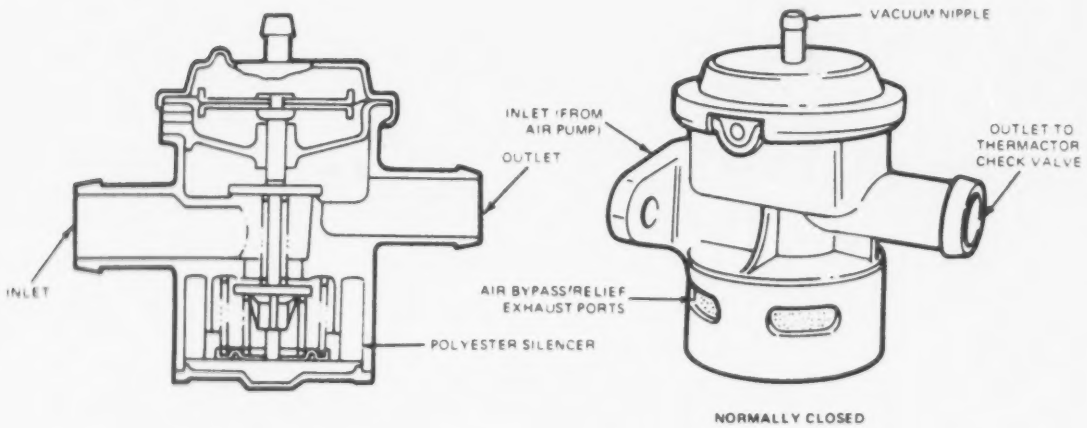
3. When the throttle is suddenly closed, intake vacuum goes high and fuel continues to enter the cylinder faster than it can be burned. The unburned fuel is dumped into the hot exhaust and, if air from the air pump continues to flow into the exhaust, a backfire will occur.

   a. The diverter valve diaphragm is connected to the intake manifold and the diaphragm senses the high vacuum during deceleration.

   b. The high vacuum causes the diaphragm to move against spring pressure, shutting off airflow to the exhaust and sending the air pump air into the atmosphere, thus preventing a backfire.

   c. When vacuum returns to normal, spring pressure overcomes vacuum and the valve returns to the normal position, allowing airflow to the exhaust.

4. If pressure exceeds the pressure relief valve spring setting, a pressure relief valve vents air pump pressure to the atmosphere.



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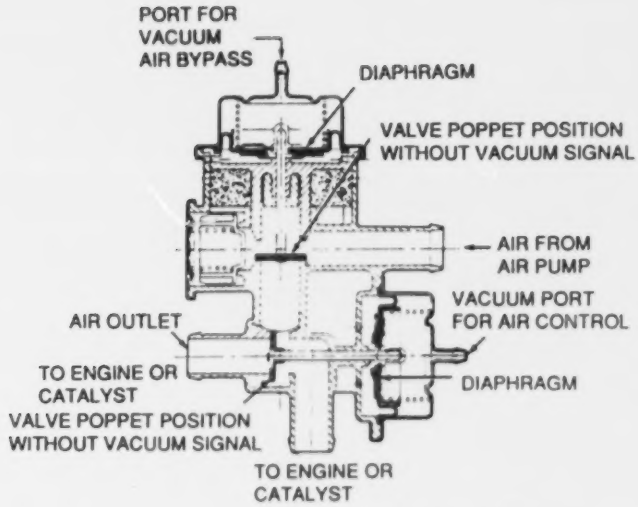
D. Air switching valve

1. Some catalyst-equipped vehicles have a valve that controls the flow of air from the air pump. As a cold engine begins to warm, this valve switches the flow of air from the exhaust manifolds (upstream) to the catalytic converter (downstream).



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a. This valve consists of a vacuum diaphragm and control valve, which is spring-loaded by the diaphragm to close the upstream passage port.

b. This position routes air from the pump to the downstream injection point (catalytic converter).

c. With the vacuum applied, the diaphragm pulls the control valve to block the downstream port and to open the air pump passage to the exhaust manifold.

2. Air switching operation (cold engine)

a. During cold engine operation, the air injection supplies air to the exhaust manifolds (upstream), thus providing extra oxygen for more complete burning of hydrocarbons and carbon monoxide emissions. Oxides of nitrogen tend to develop at higher combustion temperatures and are, therefore, not a problem at this time.

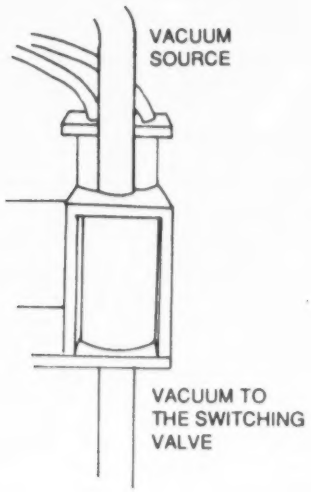
b. The extra burning raises the temperature of the exhaust system, causing the "three-way" catalytic converter to warm up faster. (See three-way catalyst later in this unit.)

3. Air switching operation (warm engine)

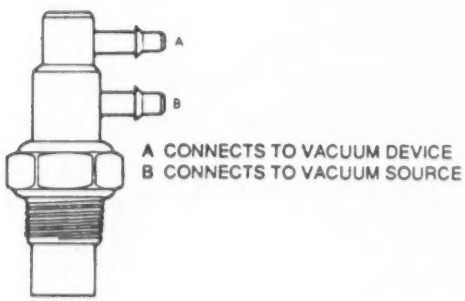
a. If the pump continues to inject air at the exhaust ports, an increase in oxides of nitrogen would occur.

b. To prevent this increase in oxides of nitrogen, the air switching valve switches airflow from the exhaust ports to the exhaust stream just ahead of the oxidation catalyst.

4. On most vehicles, the engine computer controls an electrical solenoid that energizes upon command and allows vacuum to travel to the air switching valve, which then diverts airflow.



5. A coolant vacuum switch may also be used to control the vacuum to the air switching valve.



III. Exhaust pulse air injection systems

A. A pulse air or aspirator system is a simple type of air injection system which uses one-way valves to control airflow. The one-way valves contain a single one-way check valve. Air can only flow from the air cleaner to the exhaust. Exhaust backpressure is blocked by the valve.

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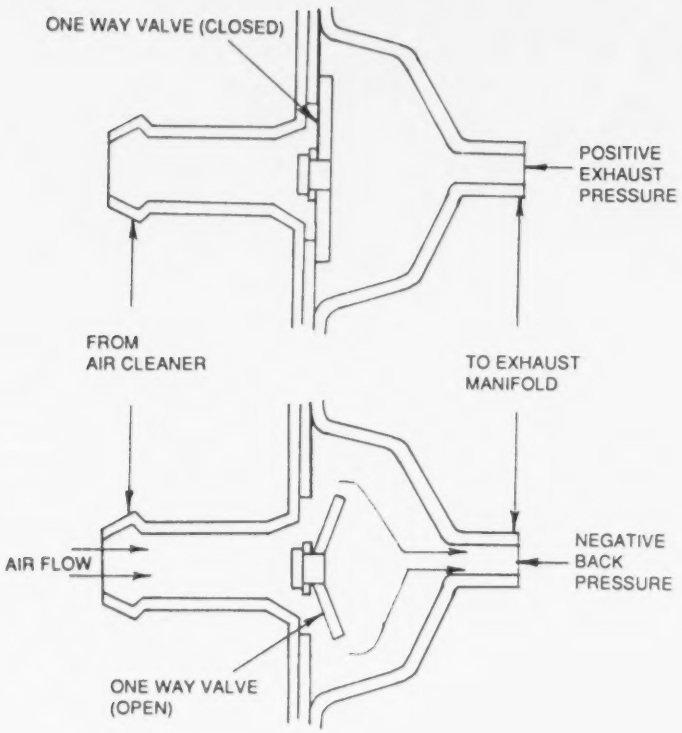


1. A pulse air or aspirator system uses no engine- driven pump. Instead, the pulse air or aspirator system uses negative pressure pulses in the vehicle exhaust to create an airflow into the exhaust.

2. During normal engine operation, there is intermittent input of exhaust gases into the exhaust manifold following each cylinder power stroke. This input of exhaust gases creates negative pressure (vacuum) in the exhaust system.

   a. At the moment a negative pressure occurs, outside air flows through the air cleaner, then through the check valve and into the manifold.

   b. When exhaust pressure increases, the check valve closes. In this way, the exhaust manifold "breathes" fresh air as needed for oxidation.

   c. This type of system is most efficient at idle and lower engine speeds where negative exhaust pulses are the greatest. At higher engine speeds, exhaust pulses smooth out and the check valves remain closed.

B. Another type of pulse air system is referred to as the pulse air feeder system. Though the pulse air feeder system is not used extensively by most vehicle manufacturers, it is commonly found on some vehicles. Many of the operating principles are the same; however, the pulse air feeder system is somewhat more complicated than the aspirator system discussed above.

1. In the pulse air feeder system, a pulse air feeder is connected to one of the engine's cylinders.

   a. Two hoses connect the feeder to the enclosed crankcase pressure of the cylinder.

   b. A third hose receives fresh air from the air cleaner.

   c. A fourth hose injects air to the exhaust.

2. The pulse air feeder encloses a single diaphragm and two reed valves.

   a. The reed valves are flapper-type, one-way check valves.

   b. They allow airflow in one direction, but block flow in the opposite direction.

   c. The main reed valve has two flappers. The sub-reed valve has one. The movement of the diaphragm, together with the action of the valves, produces air injection.

3. The pulse air feeder works in two stages.

   a. First, as the piston moves up, crankcase pressure moves the pulse air feeder diaphragm down. This downward movement closes the main reed valve outlet and opens the main reed valve inlet, which allows air to be drawn into the diaphragm chamber from the air cleaner.

   b. Second, as the piston moves down, crankcase pressure moves the pulse air feeder diaphragm up. This upward movement closes the main reed valve inlet and opens the main reed valve outlet, pumping air from the diaphragm chamber into the exhaust system.

   c. At idle, the sub-reed valve is drawn open by the negative pressure pulses which occur in the exhaust ports. This allows air to be drawn in from the air cleaner and discharged in the exhaust system. The sub-reed valve and main reed valve outlet prevent exhaust backpressure from entering the diaphragm chamber.

IV. Catalytic converters

A. The catalytic converter is different from all other automotive emission controls. The catalytic converter has no moving parts and does not depend on electrical, mechanical, or vacuum systems for its operation. The catalytic converter reduces the level of emissions in the exhaust system.

B. The catalytic converter contains a catalyst. A catalyst is a substance that causes a chemical reaction. There are three catalysts used in a catalytic converter: platinum, palladium, and rhodium.

C. Most catalytic converters are divided into two sections: one section removes hydrocarbons and carbon monoxide; the other section removes oxides of nitrogen.

D. Oxidizing catalysts in a catalytic converter contain platinum and palladium. In the presence of heat and unburned fuel, platinum or palladium (which contains hydrocarbons and carbon monoxide) adds oxygen to the reaction. This addition of oxygen is called oxidization. The oxidation of hydrocarbons and carbon monoxide produces water and carbon dioxide.

E. Reducing catalysts in a catalytic converter contain rhodium. In the presence of heat and oxides of nitrogen, rhodium removes oxygen from the compounds. This removal is called "reducing" because it reduces the amount of oxygen remaining in the compound.

F. Three-way catalysts

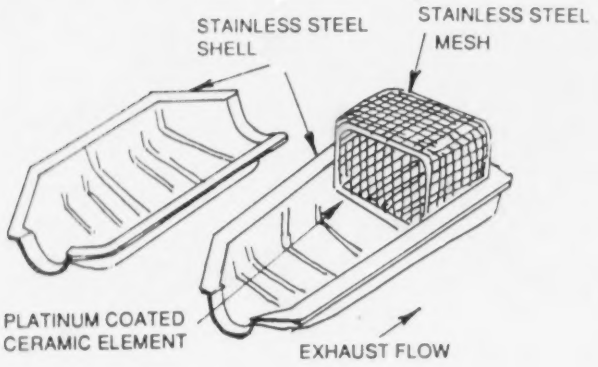
1. The oxidizing and reducing catalysts are commonly contained in a single catalytic converter, which is called a three-way catalyst. This type of converter reduces the amount of hydrocarbons, carbon monoxide, and oxides of nitrogen in automotive emissions.

2. Very precise control over air/fuel mixtures is needed to make this type of converter function properly. Therefore, electronic oxygen feedback systems are used with three-way catalysts.

G. Catalytic converter construction

1. The catalytic converter usually contains either one or two ceramic elements. A honeycomb structure, which is made of ceramic and covered with catalyst material, commonly makes up the internal structure. A stainless steel mesh protects the ceramic element from shock. Exhaust gases pass through the honeycomb and react with the catalysts.

2. A stainless steel outer shell contains the assembly.



3. Instead of the honeycomb design, some converters are filled with ceramic pellets, which are coated with catalyst material.

H. Converter operation

1. The catalytic converter works in conjunction with the air injection system.

a. When the engine is started, air is injected to the exhaust ports.

b. The combination of heat, unburned vapors and air injection begin the oxidation process in the exhaust ports or manifolds.

c. The resulting chemical reaction reduces emission levels and raises the temperature of the exhaust gases.

2. When the hot, oxidizing mixture enters the converter, the gases flow through the catalyst.

a. The catalyst increases the reaction, and much of the hydrocarbons and carbon monoxide are converted to water and carbon dioxide.

b. In the three-way catalyst, the rhodium also takes part in the reaction and removes oxygen from the oxides of nitrogen compounds formed during combustion.

3. On engines that have air switching, the switching valve is calibrated to redirect air at a specified engine temperature.

a. When this happens, air is injected into the converter assembly. Because the converter is very hot, this increases the chemical reaction.

b. The additional air improves the oxidizing efficiency of the converter.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

AIR INJECTION SYSTEMS AND CATALYTIC CONVERTERS

Instructions: Do the following tasks and answer the following questions. Write all responses on this sheet.

1. List the two exhaust gases reduced by the use of an air injection system.

2. What device directs air (from the air pump) downstream after the engine starts to warm up?

3. List the catalyst materials in a three-way catalyst.

4. The oxidizing catalyst reduces what gases in vehicle emissions?

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

AIR INJECTION SYSTEMS AND CATALYTIC CONVERTERS

(ANSWER SHEET)

1. Hydrocarbons and carbon monoxide
2. The air switching valve
3. Platinum, palladium, rhodium
4. Hydrocarbons and carbon monoxide

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT III: AIR INJECTION AND CATALYTIC CONVERTERS

LESSON 2: AIR INJECTION AND CATALYTIC CONVERTER DIAGNOSIS AND REPAIR

I. System tests (air pump injection system)

(NOTE: The following procedure is general in nature. Although most air injection/catalyst systems are basically the same, differences do exist. Consult the appropriate service manual for the vehicle to be serviced.)

A. Procedure for testing the air pump

1. Procedure for visually inspecting the vehicle

   a. Make sure pump is mounted securely.

   b. Inspect drive belt tension. Also inspect the general condition of the drive belt.

   c. Inspect hose connections.

   d. Inspect the condition of metal injection tubes and check valves.

2. Start the engine and listen for unusual noise from the air pump.

   (NOTE: A certain amount of noise is normal in an air pump system. Do not mistake normal noise for a defect.)

3. While engine is running, check for air or exhaust leaks in the plumbing of the air injection system.

4. Shut off engine, remove discharge hose from the air pump/diverter valve, and restart the engine.

5. While slowly increasing engine speed to about 1500 rpm, feel for airflow discharge from the pump. Airflow should increase as engine is accelerated. If airflow does not increase or is inadequate, any of the items listed below may be defective.

   a. Drive belt

   b. Air pump

   c. Air switching/diverter valve

B. Procedure for testing air switching valve

1. While the engine is cold, remove the hose that connects the air switching valve to the exhaust manifold.

2. Start engine and check for airflow at the hose connection. Airflow should be felt.

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3. Disconnect the hose at the catalytic converter. No airflow should be felt at this connection when the engine is cold.

4. If airflow is not correct, see the service manual for detailed testing procedures for the coolant vacuum switch or the ECM and electrical solenoid. Also check vacuum lines and electrical connections. If all components are working properly, replace the air switching valve.

5. Allow engine to warm up; then check for airflow at the hose connection to the exhaust manifold. Airflow should have stopped.

6. Airflow should now be present at the connection to the converter.

7. If air is not flowing properly, see the appropriate service manual for detailed testing procedures for the coolant vacuum switch or the ECM and electrical solenoid. Also check vacuum lines, vacuum source, and electrical connections. If all components are functioning properly, replace the air switching valve.

8. Reconnect hoses and shut off engine.

C. Procedure for testing the diverter valve

1. With the engine running, accelerate and sharply decelerate the engine.

2. Air should be heard and felt as it is discharged to the atmosphere or air cleaner (depending on the system design).

3. If the diverter valve is not functioning, check for vacuum at the valve. Replace the valve if it is receiving adequate vacuum. If adequate vacuum is not reaching the valve, check the vacuum hoses and the vacuum source.

D. Procedure for testing the check valve

1. Visually inspect valves and hoses. Valves that are badly rusted and leaking to the outside must be replaced.

2. Remove hoses at the valves, and inspect hoses for signs of exhaust burns. If evidence of burning is found, both the valve and hose should be replaced.

3. Start engine, remove each hose, and check for exhaust leakage at each valve inlet. If exhaust is felt, replace valve.

4. Check for exhaust leakage at injection tubes. Replace tubes if they are found to be leaking.

II. Replacing components of the air pump injection system

A. Replacing the air pump

1. Procedure for removing the air pump

a. Disconnect air and vacuum hose from the diverter valve.

b. Loosen pump pivot and adjusting bolts.

c. Move pump to loosen belt adjustment and remove belt.

d. Remove mounting bolts and then remove pump.

e. Remove the pulley from the pump.

f. Remove diverter valve from the pump.

2. Procedure for inspecting the air pump

a. Inspect the pump for free rotation.

b. Inspect the filter fan for damage. Replace fan if damage is found.

c. Inspect the condition of the drive belt. Replace the belt if it shows signs of wear or cracking.

d. Inspect diverter valve for damage. Replace if necessary.

e. Inspect the condition of air and vacuum hoses. Replace as necessary.

3. Procedure for installing the air pump

a. Install the air pump in reverse order of removal.

b. Tighten all fasteners to specified torque.

c. Adjust belt to proper tension.

B. Replacing the air switching/diverter valve

1. Procedure for removing the air switching/diverter valve

(NOTE: Service of the air switching and diverter valves is limited to replacement of the unit.)

a. Disconnect air and vacuum hoses from valve.

b. Remove bolts from valve mounting flange and remove valve.

2. Procedure for installing the air switching/diverter valve

a. Install valve in reverse order of removal.

b. Tighten fasteners to specified torque.

C. Replacing the check valve

1. The check valve may be either screwed on or welded to the metal air tube.

2. If the valve is screwed to the tube, it may be threaded off; however, the air hose must be removed first.

3. If the check valve is welded to the air tube, the entire tube must be replaced.

III. Testing and servicing exhaust pulse air injection systems

A. Procedure for testing the operation of pulse air injection systems

1. With engine idling in neutral, remove hose at each check valve.

2. Negative exhaust pulses (vacuum) should be felt at each check valve.

3. If hot exhaust gas is felt, the valve should be replaced.

4. Also check the condition of hoses and metal injection tubes.

B. Replacing the check valve

1. Procedure for removing the check valve

a. Disconnect hose from valve inlet.

b. Unscrew valve from metal tube.

(NOTE: On some vehicles the check valves are integral with the injection tubes and must be replaced as a unit.)

2. Procedure for installing the check valve

a. Install valve on the tube assembly. Tighten to specified torque.

b. Inspect hose. If hose is burned or deteriorated, it should be replaced.

c. Install hose.

C. Replacing the injection tube

1. Procedure for removing the injection tube

a. Remove hose from check valve inlet.

b. Remove tube assembly from engine.

c. Remove check valve from tube (if separate).

2. Procedure for installing the check valve

a. Install check valve on tube and tighten to specified torque.

b. Install tube assembly to engine and tighten all fasteners to specified torque.

c. Reinstall hose to check valve.

IV. Catalytic converter inspection and replacement

A. Inspecting the catalytic converter

1. Catalytic converters are subject to internal as well as external damage. External damage can usually be determined by a visual inspection. Internal damage is sometimes more difficult to detect.

2. Internal damage may be caused by leaded gasoline, which can coat the catalyst material with lead deposits, thus rendering the catalyst ineffective. An infrared analyzer can help isolate this problem. If this problem occurs, the catalyst must be replaced.

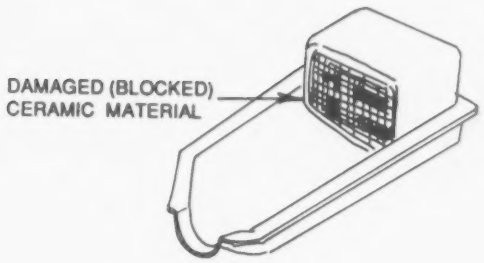
3. Another type of internal damage results from overheating of the catalyst due to an over-rich fuel mixture, an engine miss, or incorrect ignition timing.

a. When an engine develops one of the above internal problems, the catalyst will begin to overheat and may melt the catalyst inside the converter.

b. Excessive melting of the catalyst will restrict exhaust flow.

c. The converter must be replaced when damaged in this manner.

d. Before replacing the converter, the cause of the problem must first be corrected or the new converter will be damaged in a very short time.



B. Replacing the catalytic converter

1. Procedure for removing the catalytic converter

a. Raise the vehicle on a hoist or support it on safety stands.

(**CAUTION:** The catalytic converter presents a burn hazard. Allow the catalytic converter to cool before removing it.)

b. Disconnect air injection tube from converter (if so equipped).

c. Disconnect any hangers holding the catalytic converter to vehicle.

d. Disconnect bolts or clamps retaining the front of the converter.

e. Disconnect clamp or bolts retaining the rear of the converter and remove the converter from the vehicle.

2. Procedure for inspecting the catalytic converter

a. Inspect converter shell for damage.

b. Inspect converter inlet for damage to catalyst due to overheating. (The catalyst in pellet type converters cannot be checked for heat damage.)

3. Procedure for installing the catalytic converter

a. Install converter in reverse order of removal.

b. Tighten all fasteners to specified torque.

c. Start engine and inspect for leaks.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PROCEDURE FOR REMOVING AND INSTALLING A CATALYTIC CONVERTER

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, engine size, and year of the vehicle to be serviced.
2. Develop a written procedure for the safe removal of the catalytic converter.
3. Develop a written procedure for the safe installation of the catalytic converter. Include any applicable torque specifications.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING THE PERFORMANCE OF AN EXHAUST PULSE TYPE AIR INJECTION SYSTEM

Equipment:

Hand tools
Serviceable vehicle
Safety glasses

Procedure:

		Evaluation 3 2 1 N
1.	Wear safety glasses while doing all procedures on this job sheet.	— — — —
2.	Visually inspect the condition of tubes, hoses, and valves. Note condition of system in the spaces provided below.	— — — —
3.	Connect exhaust ventilation equipment to vehicle and start engine. (**CAUTION:** Be sure to use approved exhaust ventilation equipment when operating a vehicle in an enclosed area.)	— — — —
4.	Remove hose at each check valve.	— — — —
a.	With engine running at idle, check for negative exhaust pulses at each valve.	
b.	Also check for hot exhaust gases escaping through the valves.	
c.	Inspect inside of hoses for signs of burning from exhaust gases. Note results of all observations in the spaces provided below.	

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5. Based on the above tests, describe the condition of the exhaust pulse air system. Replace any parts found to be defective as directed by the instructor. — — — —

*Average of above evaluations — — — —

(*This average is a partial evaluation for Competencies L1 and L6. Final evaluation for L1 will be made at the end of JS2-L2-UV. Final evaluation for L6 will be made at the end of JS3-L2-UIII.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING THE PERFORMANCE OF AN AIR PUMP TYPE AIR INJECTION SYSTEM

Equipment:

Hand tools
Serviceable vehicle
Safety glasses

Procedure:

Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Visually inspect the air injection system. Record the results of the inspection in the spaces provided below. — — — —

   a. Pump mounting OK_____ NOT OK_____

   b. Drive belt OK_____ NOT OK_____

   c. Hose condition OK_____ NOT OK_____

   d. Tube condition OK_____ NOT OK_____

3. Connect exhaust ventilation equipment to vehicle and start engine. Listen for excessive noise from air pump. Shut off engine and record results below. — — — —

   (**CAUTION:** Be sure to use approved exhaust ventilation equipment when operating a vehicle in an enclosed area.)

   OK_____ NOT OK_____

4. Disconnect discharge hose from the air pump/diverter valve. Start engine and check airflow from air pump while increasing engine speed to 1500 rpm. Shut off engine and note results below. — — — —

   Airflow OK_____ NOT OK _____

5. Following the procedure outlined below, test the air switching valve (cold engine). _ _ _ _

   a. Disconnect the hose from the air switching valve to exhaust manifold.

   b. Start engine and check for airflow at the hose connection. Note results below.

      Airflow OK_____ NOT OK _____

   c. Allow engine to warm up, then check for airflow at the same hose connection. There should be no airflow. Record results below.

      Airflow stopped _____

      Air still flowing _____

   d. With the engine warm, remove hose and check for airflow at the connection leading to the catalytic converter. Air should be felt at this connection. Record results below.

      Airflow at converter connection _____

      No airflow at converter connection _____

6. Following the procedure outlined below, test the diverter valve. _ _ _ _

   a. Sharply accelerate and decelerate engine.

   b. Note if air is diverted to outside. Record results of this test below.

      Does diverter valve function normally?

      YES_____ NO_____

7. Procedure for testing the check valve. _ _ _ _

   a. With engine running at idle, check for exhaust leakage at each valve inlet.

   b. Shut off engine and note results of this test below.

      Check valves OK_____ NOT OK _____

8. Based on all the tests in this job sheet, describe the condition of the air injection system in the space below. _ _ _ _

9. Replace any parts found to be defective during the tests. Consult the instructor before replacing parts. _ _ _ _

*Average of above evaluations _ _ _ _

(*This average is a partial evaluation for Competencies L1 and L6. Final evaluation for L1 will be made at the end of JS2-L2-UV. Final evaluation for L6 will be made at the end of JS3-L2-UIII.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

REMOVING AND INSTALLING THE CATALYTIC CONVERTER

Equipment:

Hand tools
Serviceable vehicle
Hoist
Safety glasses

Procedure:

		Evaluation 3	2	1	N
1.	Wear safety glasses while doing all procedures on this job sheet.	—	—	—	—
2.	Place the vehicle securely on safety stands or lift it with a hoist.	—	—	—	—
3.	Complete AS1-L2-UIII. Following the procedure developed in item 2 of AS1-L2-UIII, remove the converter from the vehicle.	—	—	—	—
4.	Inspect the catalytic converter both internally and externally. Record the results of the inspection below.	—	—	—	—
5.	Using the procedure developed in item 3 of AS1-L2-UIII, install the catalytic converter.	—	—	—	—
6.	Connect exhaust ventilation equipment to vehicle and start engine. Check for exhaust leaks at converter and correct if found. (**CAUTION:** Be sure to use approved exhaust ventilation equipment when operating a vehicle in an enclosed area.)	—	—	—	—

JS3-L2-UIII

7. Shut off engine and lower vehicle. — — — —

*Average of above evaluations — — — —

(*This average is a partial evaluation for Competency L6. Final evaluation for L6 will be made below.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency L6 by averaging the evaluations of JS1-L2-UIII, JS2-L2-UIII, and JS3-L2-UIII. Use the spaces provided below.

	Evaluation 3 2 1 N
JS1-L2-UIII	— — — —
JS2-L2-UIII	— — — —
JS3-L2-UIII	— — — —
Final evaluation for Competency L6	— — — —

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT III: AIR INJECTION AND CATALYTIC CONVERTERS

UNIT III TEST

PART I. BASIC PRINCIPLES OF AIR INJECTION AND CATALYTIC CONVERTERS

SECTION A. Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.

____ 1. The air injection system does not lower oxides of nitrogen in vehicle emissions.

____ 2. The air injection system allows the air/fuel mixture to burn outside the combustion chamber.

____ 3. The maximum pressure developed by the air pump is about 50 pounds.

____ 4. The air injection check valve prevents backfire in the exhaust during deceleration.

____ 5. An air switching valve and a diverter valve are the same.

____ 6. On computer-controlled engines, air is pumped into the catalytic converter when the engine is cold.

____ 7. The pulse type injection system uses no air pump.

____ 8. The catalytic converter does not work to prevent the formation of emissions.

____ 9. Oxidizing catalysts add oxygen to hydrocarbons and carbon monoxide.

SECTION B. Read each of the below statements made by Technicians I and II. Indicate which technician is correct by placing the appropriate letter in the blank beside each question.

____ 10. TECHNICIAN I says that three-way catalytic converters do not need a precise air/fuel mixture.

TECHNICIAN II says that converters usually hold the catalyst coating on a honeycomb inside the converter.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 11. TECHNICIAN I says that air from the air pump is often pumped into the three-way catalytic converter.

TECHNICIAN II says that catalytic converts run very hot.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

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____ 12. TECHNICIAN I says that when an engine uses an air injection system, the engine can run a little richer than an engine that does not use air injection.

TECHNICIAN II says that during vehicle deceleration, air from the exhaust is diverted to the air cleaner.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 13. TECHNICIAN I says that air injection systems cannot be used in engines with an oxygen sensor because the added air would send false readings to the ECM.

TECHNICIAN II says that, if the air pump is working improperly, backfire will occur in the exhaust during deceleration.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 14. TECHNICIAN I says that the ECM uses an electronic solenoid to control the diverter valve and air switching valve.

TECHNICIAN II says pulse injection systems are most effective at low speeds and idle.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

(NOTE: The student must obtain a minimum score of ____ on Part I of the Unit III Test in order to receive an evaluation for Competencies L1 and L6.)

PART II. SERVICING AIR MANAGEMENT SYSTEMS

SECTION A. Read each of the below statements made by Technicians I and II. Indicate which technician is correct by placing the appropriate letter in the blank beside each question.

____ 15. TECHNICIAN I says that, during the inspection of an injection pump, the pump should run silently.

TECHNICIAN II says that small hose fitting leaks can be expected in air injection systems.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 16. TECHNICIAN I says that, as engine speed increases up to 1,500 rpm, the air pump output should remain constant.

TECHNICIAN II says that, when the engine is cold, the air switching valve should direct air to the catalytic converter.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 17. TECHNICIAN I says that the engine must be sharply accelerated and decelerated during a test of the diverter valve.

TECHNICIAN II says that, when the diverter valve is working correctly, air will be felt leaving the pump to the atmosphere or the air filter.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

___ 18. TECHNICIAN I says that, if the diverter valve is not operating correctly, check the vacuum source to the diverter valve.

TECHNICIAN II says to check the ECM signal to the diverter valve solenoid if the diverter valve is not operating properly.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 19. TECHNICIAN I says that, if air injection hoses appear to be burned on the inside, the diverter valve should be replaced.

TECHNICIAN II says that, if the air injection hose is removed from a check valve while the engine is running, no exhaust should be felt passing through the valve.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 20. TECHNICIAN I says that, during air pump inspection, the drive belt should be inspected.

TECHNICIAN II says that it is very important to check the diverter valve on pulse air injection systems.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 21. TECHNICIAN I says that a good air injection pump will be difficult to turn.

TECHNICIAN II says that air switching valves cannot be serviced and must be replaced if defective.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 22. TECHNICIAN I says that check valves should allow air to be drawn into the exhaust but prevent exhaust from being let out.

TECHNICIAN II says to check the condition of injection tubes when inspecting pulse air injection systems.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 23. TECHNICIAN I says that check valves (pump injection systems) are integral with injection tubes.

TECHNICIAN II says that catalytic converters can be damaged by the use of leaded fuel.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

___ 24. TECHNICIAN I says that an overly rich fuel mixture or an engine miss can damage a converter.

TECHNICIAN II says that, if the converter overheats, the catalyst will always burn out of the exhaust and lower exhaust backpressure.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

____ 25. TECHNICIAN I says to determine and correct the cause of the converter failure before replacing a converter.

TECHNICIAN II says to allow the converter to cool before changing it.

Who is right?

(a) I only
(b) II only
(c) both I and II
(d) neither I or II

(NOTE: The student must obtain a minimum score of ____ on Part II of the Unit III Test in order to receive an evaluation for Competency L6.)

ANSWERS TO UNIT III TEST

1. t
2. t
3. f
4. f
5. f
6. f
7. t
8. t
9. t
10. b
11. c
12. a
13. d
14. b
15. d
16. d
17. c
18. a
19. b
20. a
21. b
22. c
23. c
24. a
25. c

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT IV: INLET AIR TEMPERATURE AND INTAKE MANIFOLD HEAT CONTROLS

After completing this unit, the student should be able to diagnose and repair the inlet air temperature controls and intake manifold heat control system. The student will demonstrate mastery of the material by achieving a score of _____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1.

I. Identify the basic principles of inlet air temperature systems (Competencies L1 and L7, Parts I and II of the Unit IV Test).

II. Identify the construction principles of the heated air inlet system (Competencies L1 and L7, Parts I and II of the Unit IV Test).

III. Identify the procedure for testing the heated air inlet system (Competencies L1 and L7, Parts I and II of the Unit IV Test).

IV. Identify the procedure for inspecting the heated air inlet system (Competencies L1 and L7, Parts I and II of the Unit IV Test).

V. Identify the procedure for replacing components of the heated air inlet system (Competencies L1 and L7, Parts I and II of the Unit IV Test).

VI. Demonstrate the ability to:

a. Test the operation of the heated air inlet system (Competencies L1 and L7, JS1-L1-UIV).

Lesson 2.

I. Identify the basic principles of the intake manifold heat control system (Competencies L1 and L8, Pars I and III of the Unit IV Test).

II. Identify the components of the intake manifold heat control system (Competencies L1 and L8, Parts I and III of the Unit IV Test).

III. Identify the procedure for diagnosing the intake manifold heat control system (Competencies L1 and L8, Parts I and III of the Unit IV Test).

IV. Identify the procedures for replacing the intake manifold heat control valve (Competencies L1 and L8, Parts I and III of the Unit IV Test).

V. Identify the basic principles of the fuel evaporation heater (Competencies L1 and L8, Parts I and III of the Unit IV Test).

VI. Demonstrate the ability to:

a. Test the intake manifold heat control operation (Competencies L1 and L8, JS1-L2-UIV).

b. Test the performance of the fuel evaporation heater (Competencies L1 and L8, JS2-L2-UIV).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks H083 and H088.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT IV: INLET AIR TEMPERATURE AND INTAKE MANIFOLD HEAT CONTROLS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: HEATED AIR INLET SYSTEMS

   a. Information outline

   b. Job sheet

      JS1-L1-UIV: Testing the Operation of the Heated Air Inlet System

2. Lesson 2: INTAKE MANIFOLD HEAT CONTROLS

   a. Information outline

   b. Assignment sheet

      AS1-L2-UIV: Procedure for Testing Fuel Evaporation Heater Performance

   c. Job sheets

      JS1-L2-UIV: Testing the Operation of the Intake Manifold Heat Control
      JS2-L2-UIV: Testing the Performance of the Fuel Evaporation Heater

E. Unit test

F. Answers to unit test

REFERENCES

Chrysler Corporation. Oxygen Feedback Systems. Chrysler Corporation, 1983.

Chrysler Corporation. Technical Guide, 1.4, 1.6, 2.0, and 2.6 Liter Engine Performance. Chrysler Corporation, 1982.

Chrysler Corporation. Technical Guide, 3.7/5.2 Liter Engine Performance. Chrysler Corporation, 1982.

Ford Parts and Service Division. EEC System Operation. Ford Parts and Service Division, 1986.

Ford Parts and Service Division. 1984 Car Shop Manual, Emission Diagnosis. Ford Parts and Service Division, 1983.

General Motors Corporation. C-4 Engine Performance. General Motors Corporation, 1980.

General Motors Corporation. 1982 Buick Skyhawk Chassis and Body Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1982 Chevrolet Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1989 R-V-G-P Light Duty Truck Service Manual, 10-30 Series. General Motors Corporation, 1988.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Students should do AS1-L2-UIV in conjunction with JS2-L2-UIV.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT IV: INLET AIR TEMPERATURE AND INTAKE MANIFOLD HEAT CONTROLS

LESSON 1: HEATED AIR INLET SYSTEMS

I. Basic principles of inlet air temperature systems

A. When the engine is cold, the heated air inlet system heats the incoming air. The system thus warms carburetor air, which in turn improves fuel vaporization. The improved vaporization allows the air/fuel mixture to burn more thoroughly, thus lowering hydrocarbons and other exhaust pollutants.

B. The heated air inlet system also helps to prevent carburetor icing, which can occur on cold, damp days.

1. Carburetor icing is the formation of ice in the carburetor throat due to a drop in air temperature. Air temperature will drop due to an increase in air velocity through the carburetor venturi.

2. Moisture in the air freezes and the resulting ice can restrict or block flow through the carburetor throat, causing loss of power and stalling.

II. Construction of the heated air inlet system

A. The heated air inlet system uses exhaust manifold heat to warm air coming into the engine.

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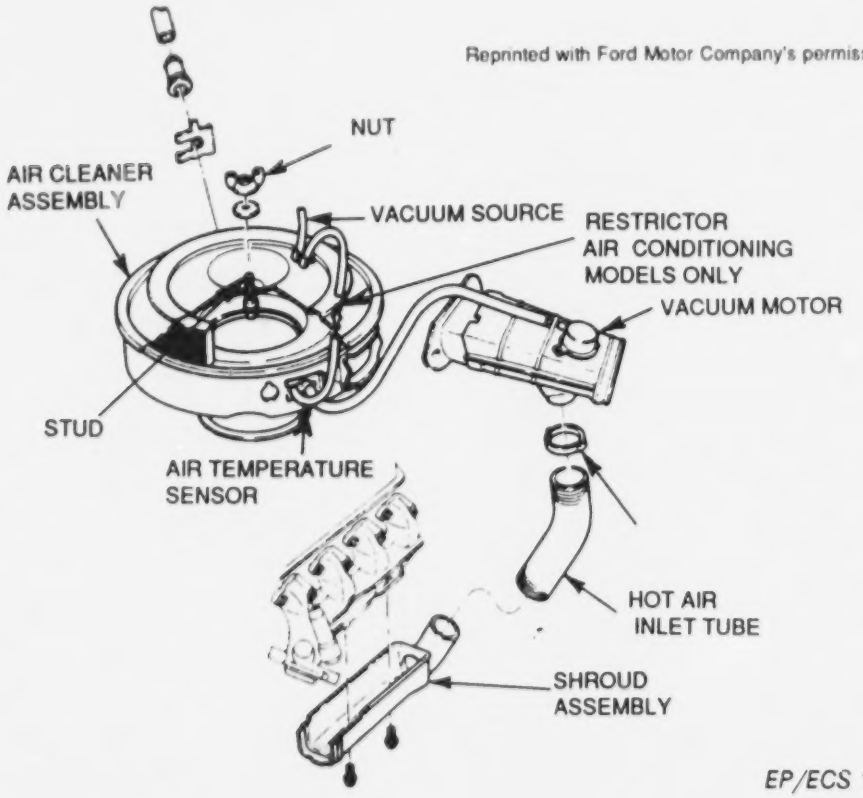


EP/ECS 115

B. The typical heated air inlet system consists of a vacuum motor in the air cleaner snorkel. The vacuum motor controls the movement of a door called a damper. The damper controls the flow of air into the engine.

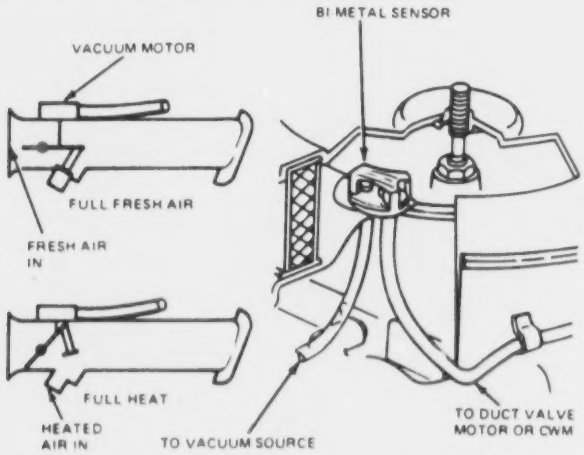
1. The vacuum motor consists of a vacuum diaphragm, which has a spring on one side and an actuator rod on the other.

2. The spring causes the diaphragm and actuator to hold the damper in a position that allows only cool outside air to enter the engine when no vacuum is applied to the diaphragm.

C. The damper pivots in the air cleaner snorkel and allows either warm or cold air to enter the engine, depending on the position of the damper.

1. When no vacuum is applied to the vacuum motor, the damper is held in the position that permits entry of cool outside air but blocks entry of heated air.

2. When sufficient vacuum is applied to the vacuum motor, spring pressure is overcome. The entry of cool air is then blocked and the damper permits heated air to enter the engine.



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D. Manifold heat stove

1. The exhaust manifold heat stove consists of a sheet metal shroud that surrounds the exhaust manifold.

2. Exhaust does not pass through the shroud. Only air which has been heated as it passes next to the exhaust manifold passes through the shroud.

3. An opening in the shroud allows the connection of a duct that delivers the heated air to the air cleaner.

4. The heat stove is commonly attached to the exhaust manifold by bolts or rivets.

E. Bi-metal temperature sensor

1. The sensor is mounted in the air cleaner and is designed to allow vacuum flow from an intake manifold vacuum source to the vacuum motor when the temperature of the air in the air cleaner is cool (approximately 50 degrees Fahrenheit).

a. The vacuum applied to the vacuum motor closes the damper to outside air.

b. This closing of the damper allows heated air from around the exhaust manifold to be drawn into the engine.

2. As the temperature of the air in the air cleaner increases, the temperature sensor opens an air bleed.

a. The opening of the air bleed results in the bleeding off of the vacuum rather than the closing of the damper.

b. The diaphragm spring in the vacuum motor forces the movement of the diaphragm, which in turn moves the damper, closing off the flow of warm air and opening the air cleaner snorkel to outside air.

III. Procedure for testing the heated air inlet system

A. The engine must be cool. If engine is warm (above room temperature), remove the top of the air cleaner and cool the temperature sensor with a cool, wet rag.

B. If air cleaner is equipped with a cold air intake hose, it must be removed.

C. Look at the damper inside the air cleaner snorkel. The damper should be open to outside air with the engine off. If the damper is closed, check for binding of the damper. Use a mirror and light if necessary to see inside the snorkel.

D. Connect exhaust ventilation equipment to the vehicle and start the engine. Watch the damper movement inside the air cleaner snorkel.

1. When the engine is first started, the valve should close. As the air cleaner warms up, the valve should slowly open.

2. If the valve does not close when the engine is started, check for vacuum at the vacuum motor.

a. If no vacuum is present at the vacuum motor, check for vacuum to the bi-metal temperature sensor and the condition of hoses.

b. If vacuum is present at the vacuum motor, check for binding in the damper and actuator rod.

c. If vacuum is present at the sensor, the sensor is properly cooled, and the hoses are in good shape and properly connected, replace the sensor. If damper moves freely, replace the diaphragm.

IV. Procedure for inspecting the heated air inlet system

A. Inspect the condition of the heat stove around the exhaust manifold. The stove must be securely attached to the manifold. If the stove is rusted out, broken, or loose, it must be repaired or replaced.

B. Inspect the condition of the duct between the heat stove and the air cleaner. On some vehicles, the duct is made of sheet metal; on most vehicles, however, the duct is made of a heat-resistant, flexible tubing. Replace the duct if broken, cracked, or missing.

C. Inspect air cleaner and the air cleaner housing. If there is a hole in the housing, if the air cleaner lid gasket is defective, or if the lid does not fit properly, the system will continually pull in cool air and thus defeat the purpose of the heated air inlet system.

D. Inspect vacuum hose to bi-metal temperature sensor. Check the hose leading to the vacuum actuator motor for cracking, breakage, and routing. Replace any defective or missing hoses.

E. Inspect vacuum motor, bi-metal temperature sensor, and damper as outlined earlier in this lesson.

V. Replacing components of the heated air inlet system

A. Replacing the vacuum motor

1. The vacuum motor is usually attached to the air cleaner snorkel with rivets or spot welds.

2. Procedure for removing the vacuum motor

a. Remove the air cleaner from the engine.

b. Remove the rivets by drilling them with a bit of proper size. If the motor is held to the snorkel with spot welds, drill the spot welds with a bit of proper size.

c. Raise vacuum motor, disconnect actuator rod from damper, and remove motor.

3. Procedure for installing the vacuum motor

a. Position the vacuum motor on the snorkel.

b. Connect the actuator rod to the motor and damper.

c. Secure the motor to the snorkel with pop rivets or sheet metal screws.

(NOTE: Be sure to check for interference between the screws/rivets and the damper movement.)

B. Procedure for replacing the duct

1. Loosen and raise the air cleaner from the carburetor.

2. Remove the duct from the air cleaner and stove and remove the duct. If clamps are used to hold the duct in place, it will be necessary to remove the clamps before removing the duct.

3. Install the new duct in reverse order of removal.

C. Procedure for replacing the bi-metal temperature sensor

1. Remove air cleaner from the engine.

2. Remove sensor retaining clip and remove sensor.

3. Install sensor in reverse order of removal.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING THE OPERATION OF THE HEATED AIR INLET SYSTEM

Equipment:

Serviceable vehicle
Hand tools
Safety Glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Visually inspect the condition of the heated air inlet system and record the results in the spaces provided below. — — — —

   a. Heat stove

      OK_____ NOT OK_____

   b. Warm air duct

      OK_____ NOT OK_____

   c. Air cleaner

      OK_____ NOT OK_____

   d. Vacuum hoses

      OK_____ NOT OK_____

   e. If any of the above items were marked "NOT OK," explain the problem in the spaces provided below.

JS1-L1-UIV

3. Following the procedure outlined below, test the performance of the heated air system. _____

(NOTE: Engine must be cool before this test is begun.)

a. Remove cold air intake hose (if so equipped).

b. Is damper open with engine off?

YES_____ NO_____

(NOTE: If damper is closed, the problem must be corrected before continuing.)

c. Connect exhaust ventilation equipment to vehicle and start engine. The damper valve should close when the engine is started. Does the valve close?

YES_____ NO_____

d. Observe damper valve as engine warms up. Does it slowly open until it is wide open?

YES_____ NO_____

4. If the valve does not close when the engine is started or if the valve fails to open after the engine is started, determine the cause of the problem. Describe the problem in the space below. _____

(NOTE: Use an appropriate service manual and the information found in Lesson 1 of this unit to assist in the diagnosis.)

(NOTE: Replace any system components found to be defective as directed by the instructor.)

*Average of above evaluations _____

(*This average is a partial evaluation for Competency L1. This average is also the final evaluation for Competency L7. Final evaluation for L1 will be made at the end of JS2-L2-UV.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT IV: INLET AIR TEMPERATURE AND INTAKE MANIFOLD HEAT CONTROLS

LESSON 2: INTAKE MANIFOLD HEAT CONTROLS

I. Basic principles of the intake manifold heat control system (heat riser)

A. Older automotive engines often incorporated a device in the exhaust manifold to aid in heating the air and fuel that entered the engine during cold engine operation.

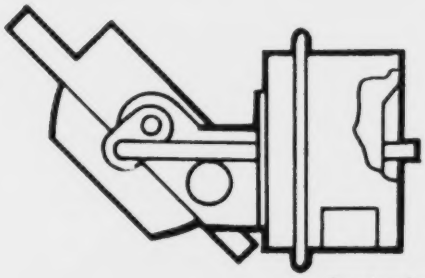
1. This older system used a spring-loaded damper valve. When the engine was cold, the damper valve partially closed the exhaust passage in one manifold and directed the hot exhaust through a passage that ran under the carburetor.

2. This system was controlled by a thermostatic spring, which caused the valve to close when the engine was cold and open as the engine warmed.

3. The system provided for better engine performance during cold engine operation through better vaporization of fuel. The common name for this older system is "heat riser."

B. Many newer automobiles use a system similar to the old heat riser.

1. This newer system also incorporates a damper in the exhaust stream. Instead of being controlled by a thermostatic spring, however, the system is actuated by a vacuum motor, which is controlled by a vacuum temperature switch.



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2. Some systems also place an electrical solenoid in the vacuum line to the vacuum motor. This solenoid is controlled by the ECM and gives more precise control of the manifold heat control system.

II. Components of the intake manifold heat control system

A. The valve assembly

1. The valve assembly in an intake manifold heat control system consists of a damper valve, which pivots in a block, which, in turn, is attached to the exhaust manifold outlet.

2. A link is attached to the valve and connects the valve with the actuator (vacuum motor).

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B. The actuator

1. The actuator in an intake manifold heat control system is a vacuum motor that opens and closes the damper.

2. The actuator diaphragm is spring-loaded to open the valve when no vacuum is applied. When sufficient vacuum is applied to the actuator, spring pressure is overcome and the diaphragm moves, forcing the valve closed.

3. The actuator assembly is mounted either directly to the valve assembly or on a bracket with an actuator rod connecting the valve and actuator.

C. Temperature vacuum switch

1. A temperature vacuum switch in the intake manifold heat control system controls the flow of vacuum to the actuator. Intake manifold vacuum is routed to the switch and onto the actuator when the engine is cold.

2. When the engine reaches a predetermined temperature, vacuum to the actuator is shut off and the damper valve opens. A bleed in the temperature vacuum switch releases the vacuum in the actuator.

III. Procedure for diagnosing the intake manifold heat control system

A. Start the engine and watch for movement of the actuator link. The link should move toward the diaphragm, closing the valve. If the valve closes, go to step B below. If the valve does not close, go to step C below.

B. Diagnostic procedure if the valve closes

1. Allow the engine to continue to warm up while observing the valve. If the valve opens, the system is working properly.

2. If the valve remains closed, check it for binding. If the valve checks "OK," replace the temperature vacuum switch.

C. Diagnostic procedure if the valve does not close

1. Disconnect the vacuum hose at the valve. Check for vacuum while the engine is cold yet running.

2. If no vacuum is present, check vacuum source and hoses. If vacuum source and hoses are "OK," replace the temperature vacuum switch.

3. If vacuum is present at the hose, make sure the valve and linkage are operating freely. If the valve moves freely, the actuator is defective and must be replaced.

(NOTE: Depending on the system, the actuator may or may not be an integral part of the valve. If it is integral with the valve, the valve and actuator must be replaced as an assembly.)

4. If the valve will not move, lubricate it and try to "free it up." If the valve still binds, it must be replaced.

IV. Replacing the intake manifold heat control valve

A. Procedure for removing the intake manifold heat control valve

1. If the actuator is integral with the valve, disconnect the vacuum hose at the actuator. If the valve and actuator are separate, disconnect the actuator link at the valve.

2. Remove exhaust pipe to manifold nuts/bolts.

3. Lower exhaust pipe and then remove the valve assembly.

B. Procedure for installing the intake manifold heat control valve

1. Clean sealing surfaces of valve and manifold.

2. If a gasket is used, install a new gasket between the manifold and valve.

3. Install valve and exhaust pipe. Tighten fasteners to specified torque.

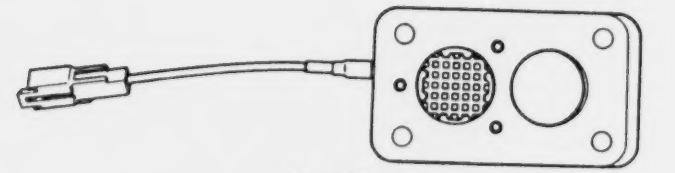
4. Reinstall actuator link or vacuum hose.

5. Start engine and check for proper operation of the system. Also check for exhaust leaks around the valve.

V. Fuel evaporation heater

A. The function of the fuel evaporation heater is similar to that of a manifold heat control valve system. This system is often referred to as an early fuel evaporation (EFS) system.

1. The fuel evaporation heater consists of a ceramic heater grid placed between the carburetor and intake manifold.



TOP VIEW

SIDE VIEW

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2. When engine temperature is low, the heater grid is "turned on" and heats the air/fuel mixture as it passes through. This heating of the air/fuel mixture allows for better fuel vaporization.

B. The fuel evaporation heater usually consists of a ceramic fuel heater grid, an engine coolant temperature switch, and a control relay. The heater control relay may be controlled by the ECM.

C. Operation of the fuel evaporation heater

1. When engine temperature is below a specified temperature (normally around 130 degrees Fahrenheit), the contacts in the coolant switch close. This energizes the heater control relay, which in turn powers the heater grid.

2. The heater will remain on until the coolant switch opens. When the coolant switch opens, the heater control relay de-energizes, turning off the heater grid.

3. The normal "on time" for the heater grid is about the first 160 seconds of cold engine operation.

D. Diagnosing the fuel evaporation heater

1. A simple heater test involves checking for radiant heat from the heater grid when the system is energized. If no heat is felt, the heater is not working.

   (**CAUTION:** Do not probe the heater grid with a foreign object when the grid is in the heat mode. Doing so may cause a direct short in the circuit. Also, the heater grid is designed to operate at a temperature of approximately 320 degrees Fahrenheit to 383 degrees Fahrenheit and could cause severe burns if touched.)

2. If the heater is not working, refer to the appropriate service manual for detailed test procedures.

E. Replacing the fuel evaporation heater

1. Removing the fuel evaporation heater

   a. Remove air cleaner.

   b. Disconnect the fuel evaporation electrical connector.

   c. Remove carburetor as outlined in the fuel section of this module.

   d. Remove fuel evaporation heater.

2. Installing the fuel evaporation heater

   a. Clean intake and carburetor mating surfaces.

   b. Install heater and carburetor in reverse order of disassembly. Tighten all fasteners to specified torque.

   c. Replace air cleaner.

   d. Start engine and check for fuel leaks.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PROCEDURE FOR TESTING FUEL EVAPORATION HEATER PERFORMANCE

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, engine size, and year of the vehicle to be serviced.

2. Develop a written procedure for safely testing the performance of the fuel evaporation heater system. Be sure to include any applicable resistance or voltage specifications.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING THE OPERATION OF THE INTAKE MANIFOLD HEAT CONTROL

Equipment:

Serviceable vehicle
Hand tools
Safety glasses

Procedure:

Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Connect approved exhaust ventilation equipment to the vehicle. — — — —

   (**CAUTION:** Be sure to use approved exhaust ventilation equipment when operating a vehicle in an enclosed area.)

3. Start the engine while noting movement of heat control valve actuator link. Begin the test when the engine is cold. Answer the questions below. — — — —

   a. Does the link move toward the diaphragm?

      YES_____ NO_____

   b. If "YES" was marked above, go to item 4 below. If "NO" was marked above, go to item 5 below.

4. As the engine continues to run and warm up, watch the actuator link. Record observations below. — — — —

   a. Does the link move back and open the valve?

      YES_____ NO_____

   b. If "YES" was marked above, the system is functioning normally and the job sheet is complete. Turn the engine off.

   c. If "NO" was marked above, go to item 6 below.

5. If valve did not close, determine the cause of the problem. Describe the problem in the space below. — — — —

   (NOTE: Use an appropriate service manual and the information provided in Lesson 2 of this unit.)

   (NOTE: After determining the problem, correct the problem as directed by the instructor. After the correction is made, proceed with step 3 and complete the job sheet.)

6. If the valve did not open as it should, determine the cause of the problem. Describe the problem in the space provided below. _____

(HINT: Use an appropriate service manual and the information provided in Lesson 2 of this unit.)

(NOTE: After determining the problem, correct the problem as directed by the instructor. After correction is made, repeat item 4 above and complete the job sheet.)

*Average of above evaluations _____

(*This average is a partial evaluation for Competencies L1 and L8. Final evaluation for L1 will be made at the end of JS2-L2-UV. Final evaluation for L8 will be made at the end of JS2-L2-UIV.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING THE PERFORMANCE OF THE FUEL EVAPORATION HEATER

Equipment:

Serviceable vehicle
Hand tools
Test lamp
Ohmmeter
Special tools as outlined in assignment sheet
Safety glasses

Procedure:

Evaluation
3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Complete AS1-L2-UIV. Following the procedure developed in AS1-L2-UIV, test the operation of the fuel evaporation heater. Record test results. — — — —

   (**CAUTION:** Do not probe the heater grid with a foreign object when the grid is in the heat mode. Doing so may cause a direct short in the circuit. Also, the heater grid is designed to operate at a temperature of approximately 320 degrees Fahrenheit to 383 degrees Fahrenheit and could cause severe burns if touched.)

   Relay function

   OK_____ NOT OK_____

   Coolant switch function

   OK_____ NOT OK_____

   Heater grid function

   OK_____ NOT OK_____

3. Based on the above tests, describe the condition of the fuel evaporation system. — — — —

*Average of above evaluations — — — —

(*This average is a partial evaluation for Competencies L1 and L8. Final evaluation for L1 will be made at the end of JS2-L2-UV. Final evaluation for L8 will be made at the end of this job sheet.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency L8 by averaging the evaluations of JS1-L2-UIV and JS2-L2-UIV. Use the spaces provided below.

	Evaluation 3 2 1 N
JS1-L2-UIV	— — — —
JS2-L2-UIV	— — — —
Final evaluation for Competency L8	— — — —

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT IV: INLET AIR TEMPERATURE AND INTAKE MANIFOLD HEAT CONTROLS

UNIT IV TEST

PART I. PRINCIPLES OF INLET AIR TEMPERATURE AND INTAKE MANIFOLD HEAT CONTROLS

SECTION A. Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.

___ 1. Fuel will vaporize better in warm air than in cold air.

___ 2. Air is warmed by the exhaust manifolds on inlet air temperature emission systems.

___ 3. An electrical motor moves the diverter valve, which allows the engine to receive warm air.

___ 4. On inlet air temperature emission systems, the manifold heat stove allows exhaust gases to pass through it.

___ 5. On inlet air temperature emission systems, the bi-metal temperature sensor sends an electrical signal to the ECM.

___ 6. Some models of vehicles close off one exhaust port to warm the carburetor.

___ 7. Vacuum motors are used on heat riser assemblies.

___ 8. Heat riser systems use a throttle vacuum switch to control the valve.

___ 9. A fuel evaporation heater heats the fuel evaporation reserve.

___ 10. The fuel evaporation heater must heat the fuel to around 130 degrees Fahrenheit.

SECTION B. Read each of the below statements made by Technicians I and II. Indicate which technician is correct by placing the appropriate letter in the blank beside each question.

___ 11. TECHNICIAN I says that the bi-metal temperature sensor must be cold before the air inlet heating system can be checked.

TECHNICIAN II says that, when the engine is not running, the air inlet damper should be open to allow cool air into the engine.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

___ 12. TECHNICIAN I says that, when the temperature sensor in the air cleaner is cold, the engine will draw air from the heater stove.

TECHNICIAN II says that, if the damper valve is closed when the engine is started, the damper is probably defective.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

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____ 13. TECHNICIAN I says that vacuum should always be present at the air temperature switch when the engine is running.

TECHNICIAN II says that the vacuum running to the air temperature switch is ported so that vacuum is not present at the switch during idle.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

____ 14. TECHNICIAN I says that the damper should always be checked for binding before a vacuum motor is replaced.

TECHNICIAN II says that, if vacuum is applied to the vacuum motor, the damper cannot bind tight enough to prevent movement.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

____ 15. TECHNICIAN I says that, on intake manifold heating systems, the actuator link should move to close the valve when the engine is cold.

TECHNICIAN II says that a thermal vacuum switch is used to control the timing of some intake manifold heating systems.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

____ 16. TECHNICIAN I says that a binding heater valve can be re-used if it is stuck open.

TECHNICIAN II says that the heat riser valve is never integrated with the vacuum motor because of the great heat generated by the exhaust system.

Who is right? (a) I only (b) II only
(c) both I and II (d) neither I or II

(NOTE: The student must obtain a minimum score of ____ on Part I of the Unit IV Test in order to receive an evaluation for Competency L1.)

PART II. INLET AIR TEMPERATURE CONTROL

SECTION A. **Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.**

____ 17. If the heater stove is loose, it must be repaired.

____ 18. When inspecting the condition of the heated air system, the technician should make sure that the duct between the manifold and air cleaner is in place.

____ 19. A defective air filter will defeat the purpose of a heated air induction system.

____ 20. Faulty vacuum motors on heated air emission systems must be replaced rather than repaired.

____ 21. The temperature sensor used on heated air emission systems is removed by unscrewing it from the air filter.

(NOTE: The student must obtain a minimum score of ____ on Part II of the Unit IV Test in order to receive an evaluation for Competency L7.)

PART III. INTAKE MANIFOLD HEAT CONTROL

SECTION A. **Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.**

____ 22. When removing the manifold heat control valve, disconnect the wiring running to the valve switch.

____ 23. The exhaust manifold is raised off the exhaust pipe to gain access to the heat riser valve.

____ 24. After installing a heat riser valve, check the exhaust for leaks.

____ 25. On some vehicles no gasket is used between the heat riser and the exhaust pipe.

(NOTE: The student must obtain a minimum score of ____ on Part III of the Unit IV Test in order to receive an evaluation for Competency L8.)

ANSWERS TO UNIT IV TEST

1. t
2. t
3. f
4. f
5. f
6. t
7. t
8. f
9. f
10. f
11. c
12. a
13. a
14. a
15. c
16. d
17. t
18. t
19. f
20. t
21. f
22. f
23. f
24. t
25. t

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT V: SPARK TIMING AND IDLE SPEED CONTROLS

UNIT OBJECTIVE

After completing this unit, the student should be able to test and repair components of spark control and idle speed control systems. The student will demonstrate mastery of the material by achieving a score of _____ on the unit test and successfully performing specific tasks.

SPECIFIC OBJECTIVES

After completing the lessons in this unit, the student should be able to:

Lesson 1.

I. Identify the basic principles of spark timing and idle speed controls (Competencies L1 and L3, Parts I and II of the Unit V Test).

II. Identify the characteristics of and testing procedures for dual diaphragm distributor advance (Competencies L1 and L3, Parts I and II of the Unit V Test).

III. Identify the characteristics of and testing procedures for the transmission-controlled spark system (Competencies L1 and L3, Parts I and II of the Unit V Test).

IV. Identify the characteristics of a spark delay valve (Competencies L1 and L3, Parts I and II of the Unit V Test).

V. Identify the characteristics of electronic spark timing (Competencies L1 and L3, Parts I and II of the Unit V Test).

VI. Demonstrate the ability to:

a. Test dual diaphragm distributor advance/retard mechanism (Competencies L1 and L3, JS1-L1-UV).

b. Test a transmission-controlled spark system (Competencies L1 and L3, JS2-L1-UV).

Lesson 2.

I. Identify the characteristics of and testing procedures for the deceleration valve (Competencies L1 and L4, Parts I and III of the Unit V Test).

II. Identify the characteristics of and testing procedures for the idle speed control (Competencies L1 and L4, Parts I and III of the Unit V Test).

III. Demonstrate the ability to:

a. Test the operation of the deceleration (Competencies L1 and L4, JS1-L2-UV).

b. Test and adjust the idle speed controller motor (Competencies L1 and L4, JS2-L2-UV).

ASE TASKS COVERED IN THIS UNIT

I. The job sheets in this unit cover ASE tasks H064-H070.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT V: SPARK TIMING AND IDLE SPEED CONTROLS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: SPARK TIMING CONTROLS

   a. Information outline

   b. Assignment sheets

      AS1-L1-UV: Procedure for Testing Dual Diaphragm Distributor Advance/Retard
      AS2-L1-UV: Procedure for Testing the Transmission-Controlled Spark System

   c. Job sheets

      JS1-L1-UV: Testing the Dual Diaphragm Distributor Advance/Retard
      JS2-L1-UV: Testing the Operation of the Transmission-Controlled Spark System

2. Lesson 2: IDLE SPEED CONTROLS

   a. Information outline

   b. Assignment sheets

      AS1-L2-UV: Procedure for testing the Operation of the Deceleration Valve
      AS2-L2-UV: Procedure for Testing and Adjusting the ISC Motor

   c. Job sheets

      JS1-L2-UV: Testing the Operation of the Deceleration Valve
      JS2-L2-UV: Testing and Adjusting the ISC Motor

E. Unit test

F. Answers to unit test

REFERENCES

Chrysler Corporation. Oxygen Feedback Systems. Chrysler Corporation, 1983.

Chrysler Corporation. Technical Guide, 1.4, 1.6, 2.0, and 2.6 Liter Engine Performance. Chrysler Corporation, 1982.

Chrysler Corporation. Technical Guide, 3.7/5.2 Liter Engine Performance. Chrysler Corporation, 1982.

Ford Parts and Service Division. EEC System Operation. Ford Parts and Service Division, 1986.

Ford Parts and Service Division. 1984 Car Shop Manual, Emission Diagnosis. Ford Parts and Service Division, 1983.

General Motors Corporation. C-4 Engine Performance. General Motors Corporation, 1980.

General Motors Corporation. 1982 Buick Skyhawk Chassis and Body Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1982 Chevrolet Service Manual. General Motors Corporation, 1981.

General Motors Corporation. 1989 R-V-G-P Light Duty Truck Service Manual, 10-30 Series. General Motors Corporation, 1988.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Students should do AS1-L1-UV in conjunction with JS1-L1-UV; AS2-L1-UV in conjunction with JS2-L1-UV; AS1-L2-UV in conjunction with JS1-L2-UV; and AS2-L2-UV in conjunction with JS2-L2-UV.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT V: SPARK TIMING AND IDLE SPEED CONTROLS

LESSON 1: SPARK TIMING CONTROLS

I. Basic principles of spark timing and idle speed controls

A. Proper spark timing plays an important role in the reduction of exhaust emissions. Various devices are used to help accurately control spark timing. In most of the vehicles built today, the spark timing is controlled by the engine-control computer. Spark timing is an integral part of the computer system.

B. Systems that do not use engine-control computers employ other ways of controlling spark timing. Some of these systems are the dual diaphragm distributor and the transmission-controlled spark.

II. Dual diaphragm distributor advance

A. The dual diaphragm distributor advance system is used on some vehicles to help reduce the production of hydrocarbons and carbon monoxide. The dual diaphragm distributor advance system increases the range of advance/retard over regular vacuum advance systems. During idle and deceleration, timing is retarded. This allows for better combustion during these times.

B. Operation of dual diaphragm distributor advance

1. Two diaphragms inside the advance/retard mechanism control timing according to vacuum signals.

2. The outer or primary diaphragm functions as a standard single diaphragm vacuum advance unit. Ported vacuum is applied to this diaphragm.

3. The rear or secondary diaphragm retards timing by moving the breaker plate/pickup coil.

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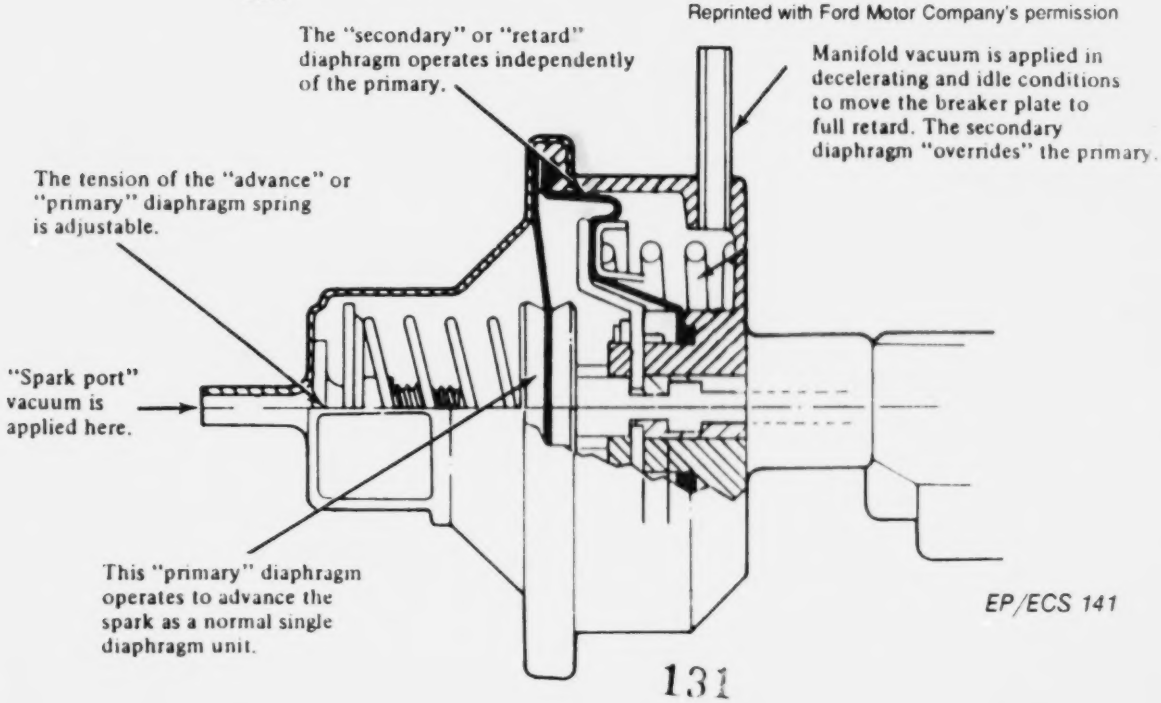
The "secondary" or "retard" diaphragm operates independently of the primary.
Manifold vacuum is applied in decelerating and idle conditions to move the breaker plate to full retard. The secondary diaphragm "overrides" the primary.
The tension of the "advance" or "primary" diaphragm spring is adjustable.
"Spark port" vacuum is applied here.
This "primary" diaphragm operates to advance the spark as a normal single diaphragm unit.

EP/ECS 141

C. Testing advance/retard mechanism

(NOTE: Procedure for testing advance/retard mechanism will vary, depending on the vehicle. Consult the appropriate service manual when working with a specific vehicle.)

1. Procedure for testing advance operation

   a. Disconnect vacuum lines from both the inner and outer diaphragms. Plug the line removed from the inner diaphragm.

   b. Connect a tachometer and timing light to the engine. Start engine and increase idle speed to 1,500 rpm.

   c. Check ignition timing with engine held at this speed.

   d. Connect the carburetor vacuum line to the outer diaphragm. The timing should immediately advance.

   e. If timing does not advance, first check for vacuum at the hose just connected. If vacuum is present, check for binding of distributor advance mechanism. If OK, replace the vacuum advance/retard unit.

2. Testing retard operation

   a. Readjust idle speed to 550 rpm.

   b. Using a timing light, check the ignition timing.

   c. Remove the plug from the manifold vacuum line and connect the line to the inner diaphragm.

   d. The timing should retard immediately.

   e. If timing does not retard, first check for vacuum at the hose just connected. If vacuum is present, check for binding of distributor advance/retard mechanism. If OK, replace the vacuum advance/retard unit.

III. Transmission-controlled spark (TCS)

A. Some vehicles are equipped with a system that allows the vacuum advance to operate only after the vehicle is in high gear.

B. In this system, a solenoid valve in the vacuum line to the distributor vacuum advance is turned on and off by a switch located inside the vehicle transmission.

1. When the vehicle is in the lower gears, the transmission switch turns on the solenoid, blocking flow of vacuum to the advance diaphragm.

2. When the vehicle is in high gear, the transmission switch cuts off current to the solenoid and the vacuum advance functions normally.

3. A temperature vacuum switch is placed in the system and overrides the TCS, thus providing vacuum to the vacuum advance during cold engine operation and (in some cases) when the engine overheats (over 210 degrees Fahrenheit.)

4. Some systems incorporate the temperature vacuum switch (TVS) and the transmission-controlled spark (TCS) solenoid into one unit.

C. Testing transmission-controlled spark operation

(NOTE: This procedure will vary. Consult the appropriate service manual when working with a specific vehicle.)

1. Raise and support the vehicle with the wheels off the ground.

2. Connect timing light/meter to engine.

3. Start engine and bring to operating temperature.

4. Disconnect vacuum advance hose. Increase engine speed while checking for maximum advance (base timing plus centrifugal advance) with hose disconnected.

5. Reconnect vacuum hose to vacuum advance and check for maximum advance with hose connected. Timing should not increase over maximum timing with hose disconnected. If timing increases, check transmission switch and solenoid valve.

6. Operate vehicle in high gear while the vehicle is still supported with wheels off the ground. Note maximum timing. Timing should now advance over maximum timing with hose disconnected. If timing does not advance, check vacuum supply and hoses, transmission switch, and vacuum advance unit.

IV. Spark delay valve

A. The spark delay valve is a small plastic valve that is placed in the vacuum line to the distributor advance. The delay valve works to reduce exhaust emissions by delaying spark advance during rapid acceleration and by shutting off spark advance immediately upon deceleration.

B. The spark delay valve is a one-way valve. If the spark delay valve is installed backward, it will not function. The spark delay valve is not serviceable; the valve must be replaced if it does not allow vacuum to pass.

V. Electronic spark timing

A. Electronic spark timing systems control spark timing more accurately than do standard vacuum and centrifugal advance systems. This accuracy of control provides for better performance and lower emissions.

B. On some vehicles, electronic spark timing may be the only function of an engine-controlled computer. On other vehicles, spark timing may be an integral part of the entire engine-controlled computer system.

C. Operation of the electronic spark timing system is based on input sent to the computer from various sensors.

(NOTE: Procedures for diagnosing electronic spark timing vary, depending on vehicle design. Some systems use on-board diagnostics. Because these diagnostic procedures vary greatly, procedures are not provided here. Refer to the appropriate service manual when working with a specific unit.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PROCEDURE FOR TESTING DUAL DIAPHRAGM DISTRIBUTOR ADVANCE/RETARD

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, engine size, and year of the vehicle to be serviced.
2. Develop a written procedure for testing the dual diaphragm distributor advance/retard unit.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PROCEDURE FOR TESTING THE TRANSMISSION-CONTROLLED SPARK SYSTEM

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, engine size, and year of the vehicle to be serviced.
2. Develop a written procedure for safely testing the operation of the transmission-controlled spark system.

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MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING THE DUAL DIAPHRAGM DISTRIBUTOR ADVANCE/RETARD

Equipment:

Timing light
Tachometer
Serviceable vehicle
Safety glasses

Procedure:

Evaluation 3 2 1 N

1. Wear safety glasses while doing all procedures on this job sheet. — — — —

2. Connect exhaust ventilation equipment to vehicle if work is to be performed in an enclosed area. — — — —

3. Complete AS1-L1-UV. Follow the procedure outlined in item 2 of AS1-L1-UV, test the operation of the dual diaphragm distributor advance/retard unit. — — — —

   a. Does the advance work properly?

      YES_____ NO_____

   b. Does the retard work properly?

      YES_____ NO_____

   c. If "NO" was marked for either of the above questions, determine and record the cause of the problem in the space provided below.

4. Based on the tests, what is the condition of the dual diaphragm timing unit? — — — —

*Average of above evaluations — — — —

(*This average is a partial evaluation for Competencies L1 and L3. Final evaluation for L1 will be made at the end of JS2-L2-UV. Final evaluation for L3 will be made at the end of JS2-L1-UV.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING THE OPERATION OF THE TRANSMISSION-CONTROLLED SPARK SYSTEM

Equipment:

Timing light
Hoist
Serviceable vehicle
Special tools as outlined in assignment sheet
Safety glasses

Procedure:

		Evaluation 3 2 1 N
1.	Wear safety glasses while doing all procedures on this job sheet.	— — — —
2.	Connect exhaust ventilation equipment to the vehicle if work is to be performed in an enclosed area.	— — — —
3.	Complete AS2-L1-UV. Following the procedure outlined in item 2 of AS2-L1-UV, test the operation of the transmission-controlled spark system.	— — — —
4.	Record the results of the test in the spaces provided below. If the system failed to perform as it should, determine and record the source of the problem.	— — — —

*Average of above evaluations — — — —

(*This average is a partial evaluation for Competencies L1 and L3. Final evaluation for L1 will be made at the end of JS2-L2-UV. Final evaluation for L3 will be made at the end of this job sheet.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency L3 by averaging the evaluations of JS1-L1-UV and JS2-L1-UV. Use the spaces provided below.

	Evaluation 3	2	1	N
JS1-L1-UV	—	—	—	—
JS2-L1-UV	—	—	—	—
Final evaluation for Competency L3	—	—	—	—

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT V: SPARK TIMING AND IDLE SPEED CONTROLS

LESSON 2: IDLE SPEED CONTROLS

(NOTE: Most vehicles built in the last 15 to 20 years use an idle control mechanism to improve drivability and decrease exhaust emissions.)

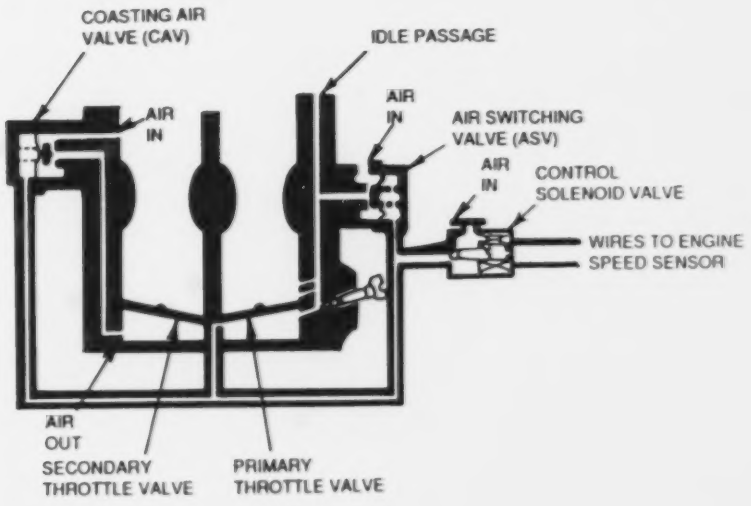
I. Deceleration valve

A. During deceleration the throttle plates are closed, resulting in engine vacuum, which causes excessive fuel to be drawn from the idle ports into the engine. This, in turn, results in increased hydrocarbons and carbon monoxide emissions.

B. The deceleration control admits an additional amount of air into the engine during these periods of high-throttle operation. This additional air makes the air/fuel mixture leaner.

C. Some types of deceleration valve systems use a vacuum-operated valve, which is built into the carburetor. The valve is controlled by an electrical solenoid and engine speed sensor.

1. The below illustration shows a system consisting of two valves, both of which admit additional air during periods of deceleration.



2. One valve (called the coasting air valve) admits additional air below the secondary throttle valve during engine deceleration. The other (called an air switching valve) admits air to the idle passage during deceleration.

a. Both valves work at the same time and both are normally closed.

b. The control solenoid "A" is also normally closed.

c. While the engine runs at idle, the engine speed sensor opens the solenoid.

d. The opening of the solenoid vents the manifold vacuum signal, so the CAV and ASV remain closed, thus preventing engine roughness or stalling due to lean air/fuel mixtures.

e. When engine speed reaches 1800 rpm, the solenoid "A" closes and intake manifold vacuum applies at the CAV and ASV diaphragms.

f. The vacuum action on the diaphragms works against the springs. Under normal driving conditions, the valves remain closed because vacuum cannot overcome the spring pressure.

g. On deceleration, vacuum is strong enough to open the CAV and ASV valves. This leans out the air/fuel mixture and reduces exhaust emission.

D. Procedure for testing the coasting air valve

1. Remove the air cleaner and run the engine at 2500 rpm. Next, release the throttle.

2. A hissing sound should be heard as the valve diaphragm opens.

3. If there is no hissing sound, remove the valve and check the diaphragm for holes. Replace the valve if necessary.

E. Procedure for testing the air switching valve

1. While the engine is idling, pinch the vacuum supply hose to the valve. The engine should run rough or stall.

2. If idle speed does not change, replace the valve.

II. Idle speed control (ISC)

A. Many feedback carbureted cars and some throttle body injected cars use an electric motor to control the idle speed with greater accuracy. The following is a description of the construction and operation of one of these idle speed control systems.

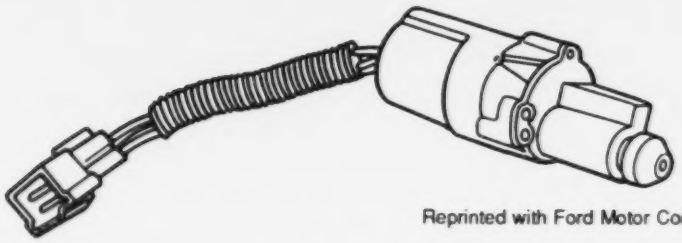
B. Construction and operation of a typical idle speed control system

1. The idle speed control motor adjusts engine idle speed according to output from the engine-controlled computer.

a. The idle speed control motor is a small, reversible electric motor. The motor, when driven in one direction, runs a plunger outward to increase idle speed.

b. When driven in the opposite direction, the plunger moves inward, slowing the idle down. The engine-control computer monitors engine load to control idle speed.

c. Some of the loads monitored by the engine control computer are the air conditioning compressor switch, transmission park/neutral switch, and the ISC throttle switch. The engine control computer uses the signal from different engine loads and adjusts idle speeds accordingly.



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2. The ISC throttle switch is mounted on the ISC motor housing.

   a. The ISC throttle switch is closed when the throttle lever contacts the ISC plunger and opens as the throttle lever moves away from the plunger.

   b. When it is closed, the engine control-computer controls the idle speed. When the switch is open, the driver is controlling engine speed.

3. The engine-control computer has the desired idle speed programmed into its memory.

   a. The actual idle speed is monitored by the engine-control computer.

   b. The engine control computer compares the actual idle speed to the programmed speed and, when the two do not match, the engine-control computer sends voltage signals to the ISC motor, which raises or lowers the idle speed.

C. Procedure for replacing the idle speed control

1. With the ignition off, disconnect wiring from the ISC motor and remove the two screws that attach the ISC and bracket assembly.

2. Install the ISC motor in reverse order of removal. Adjust the motor according to the on-car adjustment procedures described below.

D. On-car adjustments

(NOTE: The following procedure is for only one type of ISC motor. Consult the appropriate service manual when working with a specific vehicle.)

1. When a new ISC is installed, a base (minimum authority) and high (maximum authority) rpm speed check must be performed and adjustments made as required.

   a. These adjustments limit the low and high rpm to the engine-control computer.

   b. When making a low and high speed adjustment, the low speed adjustment is always made first.

   (**CAUTION:** The idle speed is controlled by the engine-control computer; therefore, do not use the ISC plunger to adjust curb idle speed.)

2. Connect a tachometer to the engine and a dwell meter to the M/C solenoid dwell lead. Set dwell meter to 6-cylinder scale regardless of engine being tested.

3. Turn air conditioner off, place transmission in park or neutral, set parking brake, and block drive wheels. Connect exhaust ventilation equipment to vehicle.

4. Start engine and run until stabilized by entering closed loop (dwell meter starts to vary).

5. Turn engine off and unplug connector at ISC motor.

   (**CAUTION:** Do not disconnect or connect ISC connector with ignition on; doing so may damage the engine-control computer.)

6. Fully retract the ISC plunger by applying 12 volts to terminal "C" of the ISC motor connection and ground lead to terminal "D" of the ISC motor connection.

   (**CAUTION:** When retracting the ISC plunger, do not leave battery voltage applied to the motor longer than necessary. Prolonged contact will damage the motor. Also never connect voltage source across terminals "A" and "B." Doing so will damage the internal throttle contact switch.)

7. Start engine and wait until the dwell meter needle starts to vary, indicating "closed loop" operation.

8. With the parking brake applied, place transmission in drive. (When servicing a vehicle with manual transmission, place the transmission in neutral.)

9. With the ISC plunger fully retracted, adjust the carburetor base (slow) idle stop screw (minimum authority) to the specified rpm.

10. Place transmission in park or neutral. Fully extend the ISC plunger by applying 12 volts to terminal "D" of the ISC motor connection; then, ground lead to terminal "C" of the ISC motor connection.

    (NOTE: Never connect voltage source across terminals "A" and "B." Doing so will damage the internal throttle contact switch.)

11. With the ISC plunger fully extended, turn ISC plunger to obtain the ISC adjustment rpm (maximum authority).

    (NOTE: This procedure requires a special adjustment tool to turn the plunger.)

    a. On automatic transmission vehicles, place transmission in drive and readjust the ISC plunger to the ISC adjustment rpm.

    b. Verify ISC adjustment rpm with voltage applied to motor. Motor will ratchet in and out.

12. Place transmission in park or neutral and turn ignition off. Disconnect 12-volt DC power source, ground lead, tachometer, and dwell meter.

13. Reconnect 4 terminal harness connector to ISC motor.

14. "Tricking" the ISC motor as described here will cause the "check engine" light to come on and an ISC motor fault code to be set in the engine-control computer memory. Restoring the system to normal operation will make the check engine light go out. However, the fault code will continue to be stored in the engine-control computer memory until cleared from the computer. See appropriate service manual for details.

E. Diagnosis of the ISC system will vary from model to model. Consult the appropriate service manual when working with a specific vehicle.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PROCEDURE FOR TESTING THE OPERATION OF THE DECELERATION VALVE

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, engine size, and year of the vehicle to be serviced.
2. Develop a written procedure for testing the deceleration valve operation.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

PROCEDURE FOR TESTING AND ADJUSTING THE ISC MOTOR

Instructions: Do the following tasks on a separate sheet of paper.

(HINT: Use an appropriate service manual.)

1. Record the make, model, engine size, and year of the vehicle to be serviced.
2. Develop a written procedure for testing the operation of the idle speed control.
3. Develop a written procedure for adjusting the idle speed control. Include any applicable specifications.

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING THE OPERATION OF THE DECELERATION VALVE

Equipment:

Serviceable vehicle
Special tools as needed
Safety glasses

Procedure:

		Evaluation 3 2 1 N
1.	Wear safety glasses while doing all procedures on this job sheet.	— — — —
2.	Complete AS1-L2-UV. Following the procedure developed in item 2 of AS1-L2-UV, test the operation of the deceleration valve. Record the results of the test below.	— — — —
	*Average of above evaluations	— — — —

(*This average is a partial evaluation for Competencies L1 and L4. Final evaluation for L1 and L4 will be made at the end of JS2-L2-UV.)

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

TESTING AND ADJUSTING THE ISC MOTOR

Equipment:

Tachometer
Serviceable vehicle
Hand tools
Special tools as needed
Safety glasses

Procedure:

		Evaluation 3 2 1 N
1.	Wear safety glasses while doing all procedures on this job sheet.	— — — —
2.	Complete AS2-L2-UV. Following the procedure developed in item 2 of AS2-L2-UV, test the operation of the idle speed controller. Record the results of the test in the spaces below.	— — — —
3.	Following the procedure developed in item 3 of AS2-L2-UV, adjust the ISC to factory specifications.	— — — —
	*Average of above evaluations	— — — —

(*This average is a partial evaluation for Competencies L1 and L4. Final evaluation for L1 and L4 will be made at the end of this job sheet.)

FINAL EVALUATION INSTRUCTIONS

I. Determine the student's final evaluation for Competency L1 by averaging the evaluations of JS1-L1-UI, JS1-L3-UI, JS1-L2-UI, JS1-L2-UII, JS1-L2-UIII, JS2-L2-UIII, JS1-L1-UIV, JS1-L2-UIV, JS2-L2-UIV, JS1-L1-UV, JS2-L1-UV, JS1-L2-UV, and JS2-L2-UV. Determine the student's final evaluation for Competency L4 by averaging the evaluations of JS1-L2-UV and JS2-L2-UV. Use the spaces provided below.

A. Final evaluation for Competency L1	Evaluation 3	2	1	N
JS1-L1-UI	—	—	—	—
JS1-L3-UI	—	—	—	—
JS1-L2-UII	—	—	—	—
JS1-L2-UIII	—	—	—	—
JS2-L2-UIII	—	—	—	—
JS1-L1-UIV	—	—	—	—
JS1-L2-UIV	—	—	—	—
JS2-L2-UIV	—	—	—	—
JS1-L1-UV	—	—	—	—
JS2-L1-UV	—	—	—	—
JS1-L2-UV	—	—	—	—
JS2-L2-UV	—	—	—	—
Final evaluation for Competency L1	—	—	—	—

B. Final evaluation for Competency L4	Evaluation 3	2	1	N
JS1-L2-UV	—	—	—	—
JS2-L2-UV	—	—	—	—
Final evaluation for Competency L4	—	—	—	—

MODULE: ENGINE PERFORMANCE

(SECTION C: EMISSION CONTROL SYSTEMS)

UNIT V: SPARK TIMING AND IDLE SPEED CONTROLS

UNIT V TEST

PART I. BASIC PRINCIPLES OF SPARK TIMING AND IDLE SPEED CONTROLS

SECTION A. Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.

____ 1. The dual diaphragm distributor retards timing during idle and deceleration.

____ 2. Dual diaphragm distributors use the chamber closest to the front for advance.

____ 3. A transmission-controlled spark system limits the spark advance while the engine is in high gear.

____ 4. The transmission-controlled spark system is overridden if engine temperature becomes extremely high.

____ 5. The spark delay valve is generally found on the distributor.

____ 6. Electronic spark timing provides lower emissions but reduces engine performance levels.

____ 7. During deceleration, the deceleration valve shuts off the fuel flow through the carburetor.

____ 8. Deceleration valves open during times of very high vacuum.

____ 9. The idle speed control system uses an electric motor to vary idle speed.

____ 10. The engine-control computer monitors the air conditioning compressor switch and the transmission park/neutral switch to control the idle speed.

SECTION B. Read each of the below statements made by Technicians I and II. Indicate which technician is correct by placing the appropriate letter in the blank beside each question.

____ 11. TECHNICIAN I says that a vacuum placed on the back of the diaphragm will cause the timing to retard.

TECHNICIAN II says that, if the timing does not change when vacuum is applied to the vacuum advance, the diaphragm is broken.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 12. TECHNICIAN I says that, on transmission-controlled spark systems, vacuum should not pass to the distributor when the transmission is in high gear.

TECHNICIAN II says that, during a test of the transmission-controlled spark system, the timing has to be checked as the vehicle is moving.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

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____ 13. TECHNICIAN I says that a spark delay valve can be installed either backward or forward.

TECHNICIAN II says that a repair manual should be used during diagnosis of an electronic spark control system.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 14. TECHNICIAN I says that, during diagnosis of the air switching valve, a hissing sound should be heard during deceleration.

TECHNICIAN II says that, during diagnosis of the coasting air valve, the engine should idle poorly when this valve is opened during idle.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

____ 15. TECHNICIAN I says that the idle speed control circuit should not be diagnosed without proper tools or repair manuals.

TECHNICIAN II says that no special tools or manuals are necessary to diagnose the idle speed control circuit.

Who is right? (a) I only (b) II only (c) both I and II (d) neither I or II

(NOTE: The student must obtain a minimum score of ____ on Part I of the Unit V Test in order to receive an evaluation for Competency L1.)

PART II. SPARK TIMING CONTROLS

SECTION A. Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.

____ 16. Before replacing a dual diaphragm vacuum advance, the technician should be sure that the vacuum source is correct.

____ 17. When inspecting the operation of the transmission-controlled spark system, the technician should make sure the engine is at operating temperature.

____ 18. The spark delay valve should always be replaced if defective.

____ 19. One basic procedure can be used to diagnose most electronic spark control systems.

____ 20. The TCS solenoid should be replaced if vacuum is found at the distributor when the transmission is in high gear.

(NOTE: The student must obtain a minimum score of ____ on Part II of the Unit V Test in order to receive an evaluation for Competency L3.)

PART III. IDLE SPEED CONTROLS

SECTION A. Read the statements below. Place a T or F in the blank beside each statement to indicate whether it is true or false.

____ 21. The idle speed control motor should be disconnected only when the ignition system is off.

____ 22. When making adjustment to the idle speed control motor, a dwell meter is used.

____ 23. The dwell meter is set to correspond to the number of cylinders when the ISC is set on fuel-injected vehicles.

____ 24. The adjustment of the ISC varies greatly from vehicle to vehicle.

____ 25. ISC adjustment determines the slowest and highest idle speeds the engine-control computer will command.

(NOTE: The student must obtain a minimum score of ____ on Part III of the Unit V Test in order to receive an evaluation for Competency L4.)

ANSWERS TO UNIT V TEST

1. t
2. t
3. f
4. t
5. f
6. f
7. f
8. f
9. t
10. t
11. d
12. d
13. b
14. d
15. a
16. t
17. t
18. t
19. f
20. f
21. t
22. t
23. f
24. t
25. t